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THE ELECTRIC LOCOMOTIVE.

The renaissance of invention was never more strongly indicated than to-day in its establishment of modern servants to human need.

The first effort to utilize steam for work in Hero's æolipile has been followed by other varied rotary engines alike in their uselessness, until the recent development of this type under the hardly accurate name of the steam turbine has furnished an engine whose economy of steam, limitations of space occupied, and uniform rotative velocity furnishes a marked change in the development of the steam engine which has otherwise advanced by hairbreadths for nearly two generations.

The automobile furnishes another example of the proverbial instance that progress advances by leaps, for the earliest attempts to apply power to locomotion was by steam carriages, and the pneumatic tire has made all possible.

It is over seventy years since Jacobi under the patronage of the Czar endeavored to make this application of electricity, and nearly twenty years later Dr. Charles G. Page in this country spent $160,000 of the money of the United States Government in making a one-half-horse-power motor.

The electric locomotive has been making history during the last year. Its promotors, in the full appreciation of the importance of the problem of making a machine which must maintain the continuity of the service, have devoted their highest skill, but proceeded conservatively, for there were both novelties to be introduced and precedents to be followed. They have produced machines which bear comparisons with the time-honored steam locomotive, and include many advantageous features which can not be ignored in railway operation.

Quicker changes of speed, either in starting or stopping, and the absence of smoke to obscure signals permits closer train leeway, and therefore enables a more dense train occupancy, which is of great importance, especially at terminals and during rush hours. The absence of reciprocating parts relieves the rails, bridges and roadway of pounding. The consumption of current only when the machine is in operation provides an economy of fuel through the adjustment of the averages at the central power station which coincidently supplies a number of these motors.

One of the early instances of the advantages of the absence of smoke occurred in the case of a tunnel in the Far West where the smoke of one locomotive has been sufficient to asphyxiate the engineers and firemen on a train following.

A powerful spring in this tunnel had been regarded as a nuisance until its waters were conducted down a penstock at

one of the portals of the tunnel to a valley at whose base it operated a power station whose current moved the trains through the tunnel.

One of the changes in the electric locomotive in comparison with its steam predecessor is its lower centre of gravity. While this permits higher speed on tangents, it applies lateral components on curves in a different manner, and in place of relying to the same extent on the elevation of the outer rail, the direct radial stresses must be considered.

The one element at this time which retards the adoption of electric locomotives to an extent which would otherwise congest the works of every establishment equipped for their manufacture is the financial one. The expense of abandoning existing locomotive plant is indeed serious, and yet, in a mechanical sense, perhaps no more difficult at one time than another.

The average life of a locomotive is generally taken at twenty years, and yet many of them may be like Mrs. Partington's stockings, which lasted just that time, thanks to the old lady's thrift in knitting on new feet each year and new legs every other year. The dictum of Horace Greeley, relative to the resumption of specie payments, "the way to resume is to resume," may apply to the electric locomotive problem.

Responsible manufacturers can furnish data as to costs of installation and operation, which will challenge such comparison with existing expenditures as to answer any question upon the profitable use of such capital, and under such conditions it is believed that the forthcoming financial market will readily respond.

The change is not necessarily a sudden one, for both types of locomotives can be used on the same track, although during the operation of a few electric locomotives the fixed charges on line plant and on a generating station operating at partial capacity would not permit the economy which would exist with the full utilization of an electric plant.

As to the old locomotives, they would be gradually transferred to other lines and disappear in time as did the horses when electricity was in like manner used for street cars.

THE ELECTRIFICATION OF THE MELBOURNE SUBURBAN RAILWAYS.

Charles Merz, consulting engineer to the Victorian Railways Commission, which is responsible for the management of the state railways of Melbourne, Australia, has presented a report going into the question of the electrification of the Melbourne suburban railway system. The report gives a rather complete résumé of the present experience with electric railroading, and the æsthetic advantages, such as deal with bodily comfort, are conceded. It is with the question of the financial and commercial desirability of the change that the report is principally concerned. It is conceded also that a heavy capital expenditure is necessary, and it is not expected that the reduction in operating expenses will be sufficient to pay the interest charges upon this capital expenditure. The advantage which naturally accrues from the more frequent service possible with electric traction must be capitalized, as the possibility of increased schedule speed is one of the characteristic features of electrical operation, particularly in suburban service. The usual features of electrical operation are enumerated; for example, the utilization of the same termini with increased train movement, and the ability to operate under closer headway and provide denser traffic conditions without enlarging or extending the existing track facilities.

Mr. Merz eliminates the three-phase system for various reasons, and devotes his calculations mainly to an analysis of the advantages and disadvantages of single-phase, alternating-current operation with an overhead system, and a protected third rail operating on direct current at 800 volts.

The possibility of extension of the present system is not very large, and it is estimated that beyond the electrification which will be determined upon at once there will not be any great extension; consequently, the advantages which the single-phase, alternating-current system holds in the event of future extensions do not seem to apply in this case. For the Melbourne system Mr. Merz concludes that the additional cost of train equipment with the single-phase system would balance the extra expenditure on the substations required in direct-current practice. This does not conform exactly to the opinions which have been reached in this country for undertakings which have a good many of the same characteristics. Mr. Merz considers also that as a mechanical structure a protected conductor rail is superior to overhead wires, both as regards simplicity and reliability; that it needs fewer repairs, and the repairs themselves are of a much simpler character. He also contends that the alternating-current equipment which would be required for the Melbourne system would be some fifty per cent heavier than that required with the direct-current system, and the latter would at the same time eliminate a good deal of wear and tear to which the heavier equipments would subject the roadbed and track.

As far as the generation of power is concerned, the report is not so definite. It may be that a portion of the power will be obtained from a water power and irrigation scheme which is now being considered. Then again, a portion of the power may be obtained from a power station to be erected some seventy miles distant, on the Brown Coal Fields. Mr. Merz considers that the initial service would have to be provided for by a steam-driven power station erected in the city of Melbourne. The initial requirements will call for a maximum load of from 32,000 to 35,000 horse-power, and an annual expenditure of some $500,000. The station would be designed to deliver electrical energy as twenty-five-cycle, three-phase current at 12,000 volts, this being generated by high-speed turbines and delivered through underground cables in the city and overhead lines in the suburban districts.

Mr. Merz presents a summary of the expenses of working with steam and electric traction which shows a saving in operating cost of $136,335 in favor of electricity. These figures, however, do not allow for interest charges upon the new capital

outlay, but it is expected that with so considerable a margin this will not be essentially a point upon which a decision will hinge. It has been pointed out so often that it seems needless reiteration to refer to it again at this time, that, whereas in the earlier investigations looking to the application of electric operation to heavy traction the advantages to be gained by the abolition of nuisances in various forms were given prime consideration, the financial consideration was kept in the background. In the investigations which are being made at the present time the æsthetic advantages are conceded and are made an incident, and not a condition. In actual practice it appears that electrification, although involving a terrific capital expenditure, is bringing about such economy of operation that upon a financial basis alone it will be selected as the means toward the end of better traveling facilities at lower costs and with a higher return upon the investment of capital.

INTRINSIC BRILLIANCY.

Electric lights from their earliest use have been considered essentially a brilliant source of illumination, and this feature has been the one which the general public has accepted as affording their chief claim to superiority. This is far from being the true condition, for unless lamps of high instrinsic brilliancy are shaded so that they do not come within the line of vision unsatisfactory results will follow.

In commercial installations lamps are often left unshaded, the excuse being the increase in luminous efficiency. As an example of unnecessary brilliancy, however, there is the case of a new building given over exclusively to creature comforts—a place of recreation and rest. Included among the various rooms is a sun parlor, sumptuously furnished, and among the luxuries are numerous reclining steamer chairs. But the tired and overworked business man seeking rest after his labors, in this haven, must look directly into clusters of six forty-candle-power clear tungsten lamps! The proprietor takes great pride in these fixtures and explains that he designed them especially so that his guests would be able to enjoy the manufactured sunlight!

That some engineers have understood the importance of the subject is undoubtedly true, but just what was the maximum which could be allowed has undergone a great change, and one for the better.

In Dr. Bell's treatise, "The Art of Illumination," he lays stress upon the importance of the subject, and as a guide to the amount which should be permissible he states: "It is a safe working rule to keep the intrinsic brilliancy of all radiants within the field of vision below five candle-power per square inch; preferably down to half that value."

The above-mentioned work was published in 1902, and since that time practically all of the improvements in the lamps and burners, both gas and electric, have been accompanied by a considerable increase in intrinsic brilliancy; whereas the standards set by illuminating engineers have been continually reduced; so that when the authors of two papers at the recent convention of the Illuminating Engineering Society set a maximum which was only a small fraction of one candle-power, there was general acquiescence.

THE GROWTH OF THE INSULATED-WIRE INDUSTRY.

Under the somewhat misleading heading given above, Mr. Ira W. Henry, in the current issue of the *India Rubber World,* discusses the use of rubber as an insulating covering for electrical conductors. He credits Samuel F. Morse, the inventor of the telegraph, with establishing the first authentic record of the use of rubber as an insulator in covering a cable made in 1842. The telegraph, being the first commercial use to which electricity was applied, called for insulated wire, and continual experiments were made by the Magnetic Telegraph Company looking to a satisfactory insulation for a submarine cable; and in 1843 a cable manufactured by Day was laid across the Hudson River from New York to Fort Lee, N. J. This cable was followed, in 1845, by another rubber-covered cable made by Charles Goodyear for Ezra Cornell.

The manufacturers of insulated wires and cables are now using enormous quantities of the best Para rubber, and the constant increase in the demand for their products has led the more far-sighted to investigate closely the supply from its fountainhead. It is stated that one large corporation found it expedient to send experts to South America to arrange for a constant supply direct from the forests, and it is also stated that large quantities were purchased on the ground at a price that paid the expenses of the trip; but financial complications arose to prevent a continuation of this enterprise.

Various processes have been perfected for the utilization of substitutes for rubber, and for certain installations these substitutes render perfectly satisfactory service. But, like every other industry, there are good substitutes and others which do not serve as substitutes at all.

Navy specifications call for a content of between thirty-nine and forty-four per cent of pure Para rubber in rubber-compound insulation, and the United States Signal Corps, which operates over 2,500 miles of rubber-insulated deep-sea cable in Alaskan territory, and over 1,600 miles of rubber cables in various circuits throughout the Philippine group, specifies a pure Para content of forty per cent. Pure Para rubber in its native state absorbs considerable moisture, and upon being dried by evaporation is oxidized and becomes hard and brittle, being rendered useless as a dielectric; so that, while Para rubber often is very essential as a base, it must have produced within it such chemical change as will render available the whole usefulness of the article. This is done by vulcanizing, which practically is the adding to the rubber of about three per cent of sulphur and heating at a certain temperature for a certain length of time. Over-vulcanizing renders the product hard and brittle, while under-vulcanizing renders it inert and flabby. Therefore, even with a fine Para as a base, the utility of a rubber insulation depends upon its process of manufacturing to make it stand the test of time.

Illuminating Engineering Society—I.

Second Annual Convention Held at Hotel Walton, Philadelphia, Pa., October 5 and 6. Report of First Day's Sessions.

THE second annual convention of the Illuminating Engineering Society was held at the Hotel Walton, Philadelphia, Pa., on Monday and Tuesday, October 5 and 6. This convention was very well attended, and the greatest interest was manifested throughout the entire proceedings. Several hundred illuminating engineers and others interested in the subject listened to the addresses and enjoyed the entertainment features which were coincident with the celebration of the 225th anniversary of the founding of the city of Philadelphia.

The first session was called to order on Monday morning at 10.40 o'clock by George Ross Green, of Philadelphia, chairman of the Committee on Arrangements. Mr. Green introduced William F. Gleason, secretary to the mayor, who, in the absence of Mayor Reyburn, welcomed the convention to the city.

Dr. Louis Bell, president of the association, delivered his annual address. He said that he desired to bring before the convention as a feature the topic of street lighting. It was 200-odd years ago that the first attempts at systematic street lighting were made. The activities of men are so far transferred from day to night at the present time that it becomes absolutely necessary to make provision for those who are traveling about after nightfall, and for the general business that is carried on at night. For this purpose plenty of light is necessary, but this light we have to a rather limited extent in most cities. The fundamental criticism against most attempts at street lighting lies not in the illuminants used, nor in their application, so much as it lies in the improper adjustment of the illumination to the needs of the city. Street lighting has been a growth and an evolution, but, like all growths, it has proceeded to a certain extent along the lines of least resistance. The result is that, looking over a city, particularly an American city, however good the intention of the city government, and however excellent the technical skill of those who furnished the light, much is still left to be desired. The difficulty lies in the fact that we spread out our illumination too thinly, so to speak.

Streets which are largely used during the evening should receive illumination commensurate with their importance. Where the night traffic is light and where passersby are few, such a street needs only light enough to enable the people to go about comfortably. A third class of street, which needs individual treatment, is the merely suburban road. The important thing with such streets is to so distribute the light that the illuminants serve to mark the way and clear the passage for the passersby.

The chief streets in this country as a rule are rather poorly lighted; the secondary streets are not particularly well lighted, and the tertiary streets frequently have only one illuminant in every long block. Dr. Bell thought that the chief streets of a city should be so well lighted that it would be possible to consult a handbook or to read the address on an envelope without having to walk half a block to get under the nearest light. In connection with this matter he stated that the foreign practice, in England and on the Continent, is to provide in the different streets light enough to read a paper by. That is the ordinary standard of illumination which is lived up to in the large foreign centres. In actual amount the lighting in London averages something like a quarter of a foot-candle, as against one-tenth, one-eighth or one-quarter that amount in the ordinary American city. One of the great points of difference between the practice here and in Europe is that diffusing globes are practically in universal use except in the United States, and therefore there is less uniformity here than almost anywhere else.

In the matter of distribution one can not sacrifice too much for the sake of uniformity. It does not take an expert in illumination to see whether a street is badly lighted or not, and it does not consequently take an illuminometer with a measurement in the thousandths foot-candle to find a half-way distance between lamps to show that improvements are necessary. The thing is strictly a practical matter, and should be treated as such.

This brings up the question of the direction of measurement. The customary measurement here is a tacit apology for bad lighting. The customary method is a measurement practically half way between the lamps, with a disc or other measuring instrument held normal to the latter. If one gauges his illumination solely by such readings as this he can be guaranteed a mighty badly lighted street in every case, because the tendency of competition, from whatever source it come, is to secure that minimum at as low a maximum as possible. Some types of illuminants have been specialized for the purpose of giving 0.02 or 0.03 of a candle-foot at some point down the street, where, if the same illuminant was designed not to give a special form of illumination, but to give the best efficiency it was capable of, it would be possible to make it light not only the distant parts of the street, but the whole of the street. Every effort toward economy should be an effort directed to increasing the total flux of light, because, with our modern instruments, there is this to be taken into consideration for street lighting: the intrinsic brilliancy is so high that some diffusion is necessary, and they are all of a character which permits of securing diffusion to get redistribution if it is desired.

Dr. Bell considered lighting of municipalities on a moonlight schedule to be entirely inadequate, and discussed the origin of this scale. He showed that there was no real relation between the diffused illumination from the full moon and that which is secured even when a street is brightly illuminated by artificial illuminants. As far as economy in lighting was concerned it would be better to put out every other light than it is to utilize the light on a regularly reduced moonlight schedule.

In concluding, Dr. Bell said that the next three or four years will work a considerable change. Illuminating engineers should insist on having more light better diffused and more evenly distributed.

There was no discussion on President Bell's address, and the report of the Committee on Nomenclature and Standards, of which Dr. A. C. Humphreys, president of Stevens Institute of Technology, is chairman, was called for. In the absence of Dr. Humphreys the report was presented by Dr. E. P. Hyde.

This report consisted, in the main, of a recapitulation of the work which the committee had done in the direction of establishing a common national and international unit of candle-power. This special work was assigned to a subcommittee, and a report from Dr. E. P. Hyde, secretary of the subcommittee, appears in the Nomenclature Committee report. A joint

committee composed of subcommittees of the American Institute of Electrical Engineers, the American Gas Institute and the Illuminating Engineering Society on February 14 adopted a resolution recommending the adoption of a common national candle unit, to be maintained at the United States Bureau of Standards, to be lower than the unit at present maintained at Washington by an amount not less than one per cent nor more than three per cent, the exact value to be agreed upon as the result of an international conference. This resolution has been endorsed by the directors of the American Institute of Electrical Engineers and approved by the council of the Illuminating Engineering Society. It will be presented to the convention of the American Gas Institute, which meets this month. The subcommittee also reported that the Bureau of Standards has entered into negotiations with the foreign laboratories in regard to possible agreement upon an international unit of luminous intensity, and the hope was expressed that final agreement may be reached very shortly.

After the presentation of the report Dr. Hyde said that it would be well if when we were speaking of photometric measurements of gas and electric lamps, or if we were speaking of photometric measurements made in this country or abroad, we could always use the same terms. It is a far cry, however, from a purely academic conception of such a condition to the practical realization of it. Many of the industries in this country have endorsed this movement and are backing it at no little inconvenience and expense to themselves: much credit is due to the Illuminating Engineering Society for taking the initiative in this matter, and credit is also due to the American Institute of Electrical Engineers and the American Gas Institute for the cordial reception which they accorded to the overtures of the Illuminating Engineering Society.

Dr. Bell said that he thought that the outlook was bright for an international standard. He had come in touch with representatives of the various interests abroad and found that they were very sympathetic in both Germany and France.

MONDAY EVENING SESSION.

The session on Monday evening was called to order by Dr. Bell at 8.30 o'clock, and the paper by T. J. Little, Jr., entitled "Modern Gas-Lighting Conveniences," was read.

This paper was devoted principally to descriptions of some of the conveniences which have obtained with modern forms of gas fixtures. The electric-spark ignition system and the pilot gas-flame system of ignition were described, and some of the adaptations of incandescent mantle burners to domestic and industrial uses were enumerated.

Dr. Bell remarked that in his experience it appeared as though ordinary electric systems of ignition for gas lighting got out of order very frequently.

Referring to this, Dr. Clayton H. Sharp asked Mr. Little whether there had been any modern developments or improvements in pneumatic lighters which would prevent this trouble from taking place. As he saw it, the chief reason for the failure of electric gas-lighting systems is due to the lack of insulation somewhere in the circuit, so that it appeared that the problem resolved itself largely into a question of proper insulation against the high electrical tensions which are involved either in the jump-spark ignition or in the make-and-break system. With regard to the pilot lighting system, Dr. Sharp asked whether there was any possibility of danger due to the extinguishing of the pilot light by drafts or air or perhaps by clogging of the pipe. In this manner a stream of gas would issue, and this brings up the question whether where water gas is used there would not be considerable danger.

F. N. Morton asked Mr. Little whether there were any developments in the self-lighting gas mantles. There was another type of igniter which was not mentioned in Mr. Little's paper, namely, the Welsbach pyrophoric alloy, about which he would be pleased to get some information.

Walton Forstall stated that it had been his experience to have the gas escape from the pilot light for about forty-eight hours before he realized it, and there was just a faint odor of gas present.

Fritz Beck described the pneumatic gas lighter, and stated that with the kind of tube now generally used it can be operated successfully on about twenty yards for one light. The number of lights to be supplied by one tube is about six, and the distance diminishes with the number of lights enclosed in one circuit. The tube is about one-sixteenth of an inch in diameter and has the advantage over electric wiring in that it does not need any insulation. There is no danger of fire or of getting out of order through lack of insulation, as is the case with the electric gas igniter. The simplicity of the parts of the pneumatic lighting system will probably induce many people to use it. It really consists of a valve, a tube and a pump, the mechanics of which are pretty generally known and understood. Another advantage of the pneumatic ignition system is that any number of lights may be turned on or off. On a chandelier of six lights it is possible to turn on one after the other or all at once, simply by pulling the line on the push-button or pressing a ball. For the ignition of a great number of lights, however, the electrical ignition is probably the best, because the distance over which the pneumatic ignition can be successfully operated is limited.

It seemed to be the consensus of opinion that the chief cause of failure with electric gas ignition systems was that the system was installed without due regard to the insulation. It is not remarkable that where single cotton insulation is used that the system should fail.

In closing the discussion Mr. Little said that the wiring necessary for an electric ignition system did not require the same restrictions as wiring for electric lights. While the potential may be high, the current carried by the wires is extremely low. Furthermore, in the make-and-break system the same insulation is not required as with the jump-spark system, where a potential of several thousand volts is necessary, depending on the number of burners in circuit. Insulating the wire by a covering is not resorted to, and in some installations the insulation would be of no avail. In these cases the wires are bare and run on insulators. The usual practice is to use a copper wire of about No. 18 Brown & Sharpe gauge. This is covered with double cotton windings, which in turn are covered with a heavy braided jacket. The entire conductor is impregnated with paraffin or some similar insulator. A good deal of the trouble which existed in the early ignition systems was due to the method of construction of the burners. Where a wipe contact was made, sometimes the wire, in wiping over, would stick and not pass back. When this happened the battery would be short-circuited and the system would be expensive to maintain. This trouble has been eliminated by the construction of the modern burners.

Mr. Little said that there was no danger from the escape of gas from an extinguished pilot burner in an ordinary room. The natural ventilation of the room would take care of the escape of gas even if it were closed pretty tightly.

Concerning the self-lighting mantle, it did not appear that one had been developed to such a point as would make it

possible to state that it was commercially practical. The action of the heat destroys the pyrophoric element, and up to the present time a satisfactory self-lighting mantle has not been produced. Concerning the pyrophoric alloy invented by Dr. von Welsbach, this is in the experimental stage. It is an interesting alloy, the product of the electrical furnace. It is an alloy of iron and cerium, and has the property of emitting a brilliant stream of sparks on being scratched with a sharp, hard surface.

Dr. A. H. Elliott presented his paper, entitled "The Illuminating Value of Petroleum Oils."

This paper gave the results of a number of tests which had been made upon various forms of burners and several qualities of kerosene oil and kerosene-oil mixtures. The author remarked particularly upon the steadiness and reliability of flat-flame lamps, even when burned with common reservoirs where the level of the oil varies as the lamp burns. It was noted that the rate of consumption and the candle-power are extremely constant. The lamps were calibrated against standard sperm candles, and it was noticed that many lamps used gave nearly twice the candle-power of sperm candles for the same weight of oil, while the round-wick lamps gave fully three times as much.

C. O. Bond stated that in his work, using the oil lamp as a standard and employing the student feed and flat-wick type of burner, up to ten hours' use a very satisfactory light was secured. He hoped that a lamp could be produced so that the conditions during a run of twenty-four hours could be checked. After twenty-four hours he found that there was, in most cases, a rather heavy incrustation of the wick where it had been exposed to the flame. Any oil lamp will be open to two objections: First, that it is a wick feed, and second, that it is surrounded by a glass chimney.

Dr. Hyde asked the author whether the absolute value of the lamp could be depended upon, and also asked whether the Methven screen arrangement could be used without having to recalibrate the outfit. In the photometry of electric lamps it is not uncommon to check up the comparison lamps several times in order to see that they have not changed, and it appeared to him that the wick might be retrimmed and the lamp restandardized at intervals. If it ran perfectly constant for eight or ten hours it seemed worth further consideration as a secondary or working standard in gas photometry.

Dr. Elliott, in closing the discussion, stated that he has used kerosene oil of a gravity as low as forty-five degrees Beaumé, and had obtained within two or three per cent of the same light as he did if he used an oil at fifty degrees Beaumé. He did not intend that the discussion should turn upon a photometric standard; he simply desired to record the reliability and photometric value of the different types of flames, and did not wish to establish any claim for the lamps as a standard. He objected to the use of the Hefner light because, in the first place, it was too small a unit, and unless a very keen photometrist was employed it was difficult to read to one-tenth of a candle. Another objection was its color. With a white light such as a Welsbach candle to test, considerable trouble was caused in matching the two shadows on the disc. The Pentane light, he thought, was too clumsy an instrument, and the expense of maintaining it was entirely too high. With kerosene oil the upkeep could be reduced very materially. He described a five-candle-power lamp which had operated for six and one-half days, being turned off each night, and varying only 0.06 of a candle during the week. The lamp was not even trimmed, but was lighted every day and allowed to burn for seven or eight hours and then blown out at night. The next morning it was turned up and lighted, care being taken not to disturb the crust. As stated before, at the end of a week it had gained 0.06 of a candle. He used a cotton wick in preference to either asbestos or felt.

The paper entitled "Street-Lighting Fixtures—Gas and Electric" was presented by H. Thurston Owens.

This paper discussed very briefly the several forms of gas and electric illuminants which are familiar to-day, and indicated the general engineering trend with regard to the installation of these sources of illumination in retail business districts, wholesale business districts, residence streets, prominent thoroughfares in residence districts, and in outlying districts.

V. R. Lansingh described a scheme of lighting which was employed on the London Bridge, at London, England. This consisted of equipping the ordinary square lamp-post with three transparent panes of glass and one pane of opal glass. This threw a considerable percentage of the light back onto the roadway, illuminating the bridge and keeping the glare out of the boatmen's eyes. The scheme could be adopted in our cities to prevent a waste of light which goes toward vacant lots and toward houses, and makes this form of illumination uncomfortable for persons sitting in front of the buildings.

Dr. Elliott stated that in Toronto reflectors were used which redistributed the light so that up and down the street the illumination was about 300 candles, with practically no illumination going to the houses at the side.

J. E. Woodwell stated that it was important to cut down the intrinsic brilliancy of the light source, and that rather than project the light up and down the street it would be better to place a larger number of units on the street, directing the light more in a downward direction. He called attention to the lighting of the Connecticut Avenue Bridge in Washington, D. C., as a successful example of street lighting. The roadway is fairly uniformly lighted, and the sources are of low intrinsic brilliancy. A strong downward distribution of light is given, and the globes are a dense opal glass, which cuts down the intrinsic brilliancy to a very low value.

The paper entitled "Structural Difficulties in Installation Work" was presented by James R. Strong.

The author considers that the best electrical installation from the point of view of the first-class contractor is that installation which requires the least amount of changing and alteration after completion. Modern electric lighting installations in the better class of buildings are of some form of concealed conduit work, with iron or steel outlet boxes at the fixture locations. Therefore, the electrical equipment is as much a part of the structure of the building as is the plumbing or heating equipment, and any additions or alterations in the conduit work after the completion of the building must, to some degree, cause weakness in walls, floors or plaster. It would seem that in designing the lighting for an office building, the proper method of procedure would be to consider each floor as a whole, bearing in mind the class of tenants likely to occupy an office building in a given locality. If the outlets for general illumination are placed on the centre line of windows and if other outlets are placed around the ceiling a short distance inside the lines of partitions, it would seem as though every possible requirement could be met by simple fixtures, and the outlets need not be capped up. This plan would probably involve a greater number of outlets in the original layout than would be absolutely necessary, but when it is considered that no changes will

probably be required, it will be appreciated that the additional first cost would be more than made up in the saving of maintenance in the first few years. The paper also discussed the arrangement of the installation for residence lighting.

Dr. Bell said that he felt that a great fault in most installations was an insufficient number of outlets. These should be allowed not only at various points in a room, but also at the central points.

G. H. Jones stated that the introduction of the modern high-efficiency unit has done more than anything else to make improvements and changes necessary in large office buildings. Heretofore the standard practice was to provide a small amount of light for general illumination and require that each desk should have a portable lamp or drop cord. Where it became necessary to shift the desks and office arrangements it resulted in either tearing up the floor or having drop cords carried all around the room. It is now becoming standard practice to have the general illumination intense enough to make all these extra lamps unnecessary. In laying out office-building lighting he recommended that no wall brackets or wall switches be installed in the interior of the walls; that is, in the walls leading from one office to another. The need for this can be done away with largely by having the wall switches put on the outside walls of the building, and if extra outlets are required they can be put on the baseboard of the outside walls and also the baseboard of the columns.

F. G. McGuire described a system of lighting which was under consideration in a building which has been erected for about ten years. The ceiling has no space back of it through which wires could be fished, and everything must run along the surface of the ceiling. All over this building a large number of drop lights have been used for illuminating purposes, and the general scheme has been to employ a network of molding, from which any number of local drops could be secured. Instead of forming receptacles at the base line, a tube was run around the entire room, which could be tapped into at any point, allowing great flexibility in the securing of side lights.

In closing the discussion, Mr. Strong said that the suggestion that the outlets in office buildings be kept off the outside walls was an excellent one. Briefly, his plan is to place a centre outlet and in addition a row of outlets, say, five feet apart, two feet from the wall, forming a square—if the room is square—around the centre outlet. With such a distance between outlets it would be possible by means of a fixture to reach a piece of furniture or desk placed in any part of the room, and while the first cost might be increased a little, the owner would be better satisfied in the long run if a simple change in fixtures could be made to take the place of tearing down the plaster or cutting holes in a brick partition. Mr. Strong stated that he was opposed to the use of moldings. They are unsightly and are dangerous, and the electrical contractor was getting beyond them.

The paper by F. E. Cady, on "The Relation Between Candle-Power and the Voltage of Different Types of Incandescent Lamps," was presented.

In this paper Dr. Cady holds that one of the more important relations governing incandescent lamps is that between voltage and candle-power. In the early days of poor voltage regulation this was evident even to the unskilled eye. At the present time, while a good system may have voltage changes large enough to have an appreciable effect on the life of lamps, they are generally too small to affect the candle-power to a noticeable extent. The author concludes that his experiments establish the following facts: The exponent for change of candle-power with change of voltage is not a constant, but a function of the watts per mean spherical candle; that this exponent is different for different types of filament, but probably very closely the same for lamps of the same type of filament when operated at the same watts per mean spherical candle; that the value of the exponent decreases as the watts per mean spherical candle decrease.

During the discussion of the paper Dr. Hyde asked whether any curves had been derived for the variation in current as compared with variation in candle-power.

Mr. Cady replied that such tests as he had been able to make indicate that these coefficients change in a very similar manner, although the change was not as marked as in the case of the change of candle-power with change of voltage. The coefficient for the change of candle-power with change of watts is smaller, and in some cases only half as great as the change of candle-power with change of voltage.

Dr. Sharp asked Mr. Cady what the change in efficiency of the filament amounted to practically in the photometry of incandescent lamps; what it amounted to in candle-power.

Mr. Cady replied that so far as he knew there were no data published either by lamp factories or the testing laboratories as to exactly what coefficient was used. He had pointed out in the paper the extreme limits over which the coefficients range.

Dr. Bell stated that in fourteen years he had measured something like 25,000 lamps, and that he could probably throw a little light on the matter by saying that there is no means known under the heavens whereby the errors due to bad sorting can be entirely eliminated.

The meeting was then adjourned until Tuesday morning.

New York Edison Entertainment.

The New York Edison Company tendered an entertainment and smoker to the electrical contractors of New York city, in connection with the New York Electrical Show, in the concert hall of Madison Square Garden on Tuesday evening, October 13. The occasion was enjoyed by about 700 or 800 contractors, and the programme, which was arranged by the United Booking Offices of America, included singing and dancing and instrumental performances of a very high order. From 9 to 11 o'clock the vaudeville arrangements held forth, and during this time cigars and other smokables were distributed with a lavish hand. After the entertainment the company's guests were invited to partake of a buffet supper, which was excellently served and greatly enjoyed. The Edison company is to be congratulated upon the handsome way in which it arranged for the entertainment and comfort of its guests.

Among those seen in the Edison box were: T. E. Murray, John W. Lieb, Jr., Arthur Williams, S. D. Sprong, F. C. Bates, Theodore Beran, Dr. George F. Sever, W. D'A. Ryan, E. B. Latham, Louis J. Auerbacher, W. H. Atkins and George H. Guy. William Marconi was an interested visitor to the Edison box during a portion of the evening.

Chicago Electrical Show.

The fourth annual Electrical Show, Chicago, Ill., to be held in the Coliseum, January 16 to 30, 1909, will surpass anything attempted heretofore, judging from preparations now being made. The beautiful decorations of the 1908 show are being enlarged upon and exhibits of many large companies are being prepared on a plan more comprehensive and attractive than ever, many working power exhibits being an added feature. Weber's band, which rendered the music at the last show, has been re-engaged. All indications point to boost for the electrical industry in general through the medium of this great exhibition.

The 213th Meeting of the American Institute of Electrical Engineers.

The 213th meeting of the American Institute of Electrical Engineers was held in the Engineering Societies Building, New York city, on Friday evening, October 9. President Louis A. Ferguson, of Chicago, Ill., called the meeting to order at 8 o'clock. The secretary announced that at the meeting of the board of directors held that afternoon 112 associate members had been elected. The following associates, upon the recommendation of the board of examiners, were transferred to the grade of membership: Robert Albert Hadfield, Mayfair, W., England; Edward Belden Merrill, Winnipeg, Canada; William Noble Dickinson, Jr., New York city.

The paper of the evening, entitled "High-Potential Underground Transmission," by Peter Junkersfeld and E. O. Schweitzer, of the Commonwealth Edison Company, Chicago, Ill., was presented by Mr. Junkersfeld. This paper, in abridged form, appears elsewhere in this issue.

In opening the discussion President Ferguson said that the subject was interesting not only from a scientific standpoint, but it was of considerable importance commercially because of the possible influence on investment and methods of operation in large power and lighting systems. The increase in value of property in the centre of cities has caused an expansion of the congested areas until, in the interest of public safety, overhead construction is necessarily limited, and we find ourselves facing the problem of placing high-tension transmission lines under ground. The possibilities of the future are so great, and the trend of the times so marked, that it would seem that the subject for discussion was a very fertile one, and it would appear very important that the large operating companies which produce electricity and sell it in bulk should make the matter of underground transmission a subject of further investigation and more serious thought.

Following President Ferguson, a discussion communicated by Charles H. Merz, chief engineer and manager of the Bulk Supply Company, Newcastle-on-Tyne, England, was read by Professor H. E. Clifford. Mr. Merz said that visiting engineers had always been impressed by the development and distribution of electrical energy in large cities of the United States. The fact that a large proportion of the work hitherto installed had been in crowded and congested districts probably explains why a conduit system had been generally adopted in this country. The solid system was preferred and largely in vogue in England, and armored cables are used largely there, and almost exclusively on the Continent of Europe. The extension of underground transmission to outlying and less congested districts will probably result in the merits of these systems of laying transmission cables being considered. For congested districts such as are met with in the centre of all of the large cities, the duct system is often the only practicable system because it is impossible to frequently take up the streets to lay further cables or carry out repairs. Accessibility to the cables is, however, some would say, the only advantage of this system, for when laid in this way the lead of the cables is probably more exposed to deterioration by electrolysis and chemical action than in either of the other two systems referred to above. In the so-called solid system the cable is laid in an earthenware or wooden trough sufficiently large to allow a three-quarters-inch clearance all around the cable, which space is filled with bitumen, pitch or similar substance. The trough is covered with three-inch brick or tile. According to the writer's experience, the solid system, in either earthenware or wooden troughs, is the cheapest of the three systems mentioned. An efficient armored cable costs, laid in the ground, in England, from five per cent to ten per cent more than a lead-covered cable laid on the solid system, but it would seem fair to say that an armored cable which is made and finished in the factory, where proper supervision is possible, should have a longer life than cables laid either on the solid system or drawn into ducts. Experience in the north of England shows that a 20,000-volt underground cable system may be installed with assurance that it will work well. In the counties of Northumberland and Durham there are now nearly 100 miles of such cables in use. The cables are three-core paper cables, lead-covered, and laid on the solid system in earthenware troughs.

H. W. Fisher, chief engineer of the Standard Underground Cable Company, said that the results of such tests as are given by the authors will add to the sum total of existing knowledge as to what voltages cables may be subjected to under working conditions. He thought, however, that under other working conditions it must be admitted that similar tests might have shown quite different results. It is therefore highly desirable that other operating companies make similar tests covering a long period of time. He said that the authors had not specified clearly what they meant by "double working voltage." With grounded neutral the voltage to ground on the 20,000-volt lines would be 11,550 volts. He would ask, therefore, if the voltage applied between conductors and ground is two times 11,500, or 23,100 volts, and that between conductors 40,000 volts. If these are the voltages applied, the test to ground is not sufficient, because in some cases the spark-gap method gave over 25,000 volts. He would suggest two and one-half times the working voltage as a figure that is more in keeping with tests made on other large installations. He took exception to the statement that asphaltum troughs certainly guard against electrolysis. If it were possible to perfectly protect a cable from moisture by asphaltum, electrolysis would not occur, but this is scarcely possible, and at the moist spots the electrolysis is greatly accentuated, causing pit-holes in the lead. He knew of cases where thousands of feet of cable laid in asphalt troughs were destroyed by electrolysis.

Henry Gorden Stott, chief engineer of the Interborough Rapid Transit Company, said that on the Manhattan elevated railway and in the subway system in New York city during the last three years there have been over 350 miles of 11,000-volt cable in service. Tables showing the classification of the troubles on this system indicated a total of seven burnouts, due to various causes, one of which was due to a surge, and one only was felt on the cable of 122 miles. The year that the subway was put into operation the cable troubles had fallen to six, due to the elimination of bad joints and various mechanical troubles. When the subway cables were put into operation the number of faults increased again. Lately, however, there have been very few faults, and in the last two years the number of burnouts amounted to 0.28 per 100 miles of cable. This is a record which is rather reassuring, and is better than is being accomplished with overhead transmission lines. So far as the discussion contributed by Mr. Merz was concerned, Mr. Stott would suggest some precaution in considering this. In the English system power was scattered between comparatively small stations. The American plants operate under entirely different conditions, and in the case of the Interborough Rapid Transit Company it was

possible to have 300,000 kilowatts on short-circuit between stations.

Mr. Stott said that the mechanical feature which was going to help out materially in the development of power plants is the induction generator. We could not go on adding indefinitely to the capacity in synchronous machines in one plant, as a point would be reached where the short-circuit current would make it impossible to take care of the automatic apparatus. In the case of a bad short-circuit the time-element relays and reverse-current relays all fall back together, and everything goes out in a large system. With the induction generator, however, the present plant can be added to indefinitely without increasing the short-circuit current.

E. J. Berg stated that he had recently had occasion to carry out some experiments on the system of the Brooklyn Edison Company. It was found that abnormal voltages occurred relatively seldom, perhaps only once a week or once in two weeks.

Wallace S. Clark said that the putting of high-voltage primary on cables for the purposes of tests did not do the cable any good, as it did not show anything and there was no assurance that the cable under test would not burn out the next day or the next hour. Insulation tests are perhaps a little better made periodically, and furthermore, with the present tendency to make paper cables with very light insulation, it is rather difficult to get good results from such tests. He believed, however, that if the same amount of attention was paid to watching for electrolysis, as many burnouts or perhaps more would be saved as in any other way.

Alex Dow stated that thirty miles of rubber-covered cables which he had put down in Detroit in 1892 were, to all intents and purposes, as good six months ago as they were the day they were put in. In Detroit the Edison company has two cables operating regularly at 23,000 volts. Each is substantially seven and one-half miles long. The cable conductor is nineteen-strand, equal to No. 2 Brown & Sharpe gauge. The cable is insulated with two-thirty-seconds-inch rubber and six-thirty-seconds-inch varnished cambric on each conductor, and three-thirty-seconds-inch varnished cambric over all, with a three-thirty-seconds-inch lead sheathing. The lead sheath is sectionalized at every second manhole between 700 and 800 feet, and a strip of the lead is removed and insulating rubber substituted in order to prevent the continual travel along the lead sheath of street railway return current. At each of these 700 or 800-foot spaces the lead is solidly connected to earth by copper ground wire. One of these cables has been in continuous service for thirteen months. It is not the older of the two cables, but it has the most continuous and useful history. It went into service on September 4, 1907, and since that time has broken down six times. One of these breakdowns was due to high temperature from a steam-heating pipe in the vicinity, and the other five are not attributable to any known cause. Four breaks were in the cable itself and two were in the joints. There were four breaks to earth and one between phases. Adding this experience to the experience with the second cable, which was actually the first cable in service, the total breakdowns are twelve, seven of which were in the joints and five in the cable. The most notable observation is that the faults that are attributable to nothing but extraordinarily high pressure seem to occur in the middle third of the cable, and are not accompanied by any particularly notable disturbances at the terminals. This seems to confirm the observation made by the authors of the paper of the finding that these disturbances do not travel the entire length of the cable, but may spend their energy in one part thereof.

Warren Partridge said that the experience of the Public Service Corporation of New Jersey with high-potential underground transmission, when reduced to burnouts per mile of cable per year, had been considerably better than the 20,000-volt experience in Chicago, as reported in the paper. When compared with the 9,000-volt system in Chicago, however, the results have been very much worse. In spite of the difficulties experienced on their system, however, it could be agreed with the authors that cable systems are fully as reliable as other elements in an electric power system.

E. E. F. Creighton said that the work presented by the authors was most valuable. If one may look into the future, it seems safe to predict that engineers of power transmission systems will some day study the conditions of service as carefully and conscientiously as the insulation is studied on a marine telegraph cable.

L. T. Robinson stated that the reference to the limitations of the oscillograph which was used was not entirely justified. As far as concerns the free periodicity of the vibrators, it is quite possible to produce moving systems in which the current passes through the strips having a frequency nearly double that which was used, or, roughly, 10,000. This is accomplished, however, at such a sacrifice of strength and size of the moving parts that it is not desirable for industrial use. In reference to the statement that the vibrators can not be made absolutely dead-beat, he thought that this must be due to a misunderstanding of what can be accomplished.

Henry Floy stated that, as far as the alternating-current, high-tension cables were concerned, the manufacturing companies were ahead of the operating conditions—that is to say, the manufacturing companies have for years been ready to furnish high-tension cables. He had recently secured figures as to the commercial financial practicability of using high-tension cables. Where conductors are intended to be used on 50,000-volt service it would appear that the thickness of insulation would become so great that three-conductor cable would be impossible, as the leading machines at present available would not be capable of producing a lead sheathing for the cable. The average price for three single-conductor cables is about $4.40 per running foot.

John W. Lieb, Jr., stated that about 1882 a fairly extensive underground system was laid in Milan, Italy, with Edison tubes. It took only about six months in that particular locality to destroy an iron tube under ground. Some time in 1887 or 1888 a line some three or four miles in length, operating on 2,000 volts alternating current, was laid under ground. This was laid with iron-banded armored lead-covered cable, and with this cable was had probably the first experience in operating alternators direct-driven and coupled in parallel. The cable has been in operation ever since, and except for the early troubles, which were due to mechanical defects in the switches and generators, this type of construction has given great satisfaction.

Mr. Lieb read a communication from Philip Torchio, of the New York Edison Company, which described some of the experiences with the New York Edison service. Since June 10, a year ago, there were twelve disturbances on the system, and of these twelve disturbances at least four were indicated by a selective ground detector located on the feeder where the lowering of resistance was going on before the ground indicator gave an indication.

Dr. C. P. Steinmetz said it was extremely satisfactory to discover that underground cable systems can be oper-

ated even when on enormous magnitude and with enormous power back of them, with high safety and a small proportion of breakdowns. It would be interesting to investigate and calculate how much stored energy there is available in the system the authors describe.

In closing the discussion, Mr. Schweitzer said that, with regard to the question of the meaning of 100 per cent above normal voltage, this had reference to 100 per cent above normal pressure of any phase to ground, and where the paper referred to 200 per cent rise in current, that meant 100 per cent above the normal full-load current.

The meeting was then adjourned.

Electric Cooking for Restaurants.

An article in *Electrical Engineering* (London), September 17, describes the results of some experiments conducted in a London restaurant with electrical cooking apparatus. The apparatus consists of an oven, a large grill measuring fifteen inches by ten inches and consuming 1,800 watts when hot; an egg poacher six and one-half inches in diameter, consuming 600 watts; a toaster, and a six-and-one-quarter-inch hot plate. The most interesting piece of apparatus is the large grill. This is constructed as follows: Under the nickel-plated cover is a pad of asbestos wool some two inches thick, beneath which is a metal reflector. A grid of spirally wound resistance wire is supported from the latter on small porcelain buttons, and the heat is reflected down onto the chop or steak placed on the grid below. A five-gallon copper boiler is used to keep water at the boiling point. This consumes 1,000 watts. A test made for eight days, during which time the plant was in use almost continuously from twelve noon to 9 P. M. daily, showed that the average consumption of the oven, which had been in use only for keeping the plates hot, was eight and three-quarter units per day; that of the egg poacher, five and one-eighth units; of the grill for chops and steaks, thirteen and one-half units, and of the small grill for toasting bread, eleven and three-quarter units. The total consumption was 313 units, making an average daily consumption of thirty-nine and one-eighth units, which, at 1.8 pence per unit makes a daily cost of three shillings eight pence for current, or about eighteen cents per day, or two cents per hour for each grill, boiling plate and oven in use. The large grill, which is capable of cooking twelve chops or steaks at one time, cooked 678 pieces of meat, at a cost for current of three-eighths of a cent per chop or steak.

STREET RAILWAY CONVENTIONS.

MEETINGS OF THE AMERICAN STREET AND INTERURBAN RAILWAY ASSOCIATION AND ITS AFFILIATED ORGANIZATIONS AT ATLANTIC CITY, N. J., OCTOBER 12 TO 16.

The annual series of conventions of the American Street and Interurban Railway Association and its affiliated organizations was opened at Atlantic City, N. J., Monday afternoon, October 12, with a meeting of the Transportation and Traffic Association. President C. Loomis Allen, of Utica, N. Y., called the meeting to order at 3 o'clock and delivered his annual address. He said that it was a cause for regret that the congratulatory remarks from the Hon. W. Caryl Ely would have to be deferred until the next day.

The work of the American Street and Interurban Railway Association will, in the future, undoubtedly be confined very largely to questions of policy and public relations, including national, state and municipal governments, and to such other matters as only the chief executive officers would be interested in.

Mr. Allen discussed the work of the Accountants', the Engineering and the Claim Agents' associations. The Transportation and Traffic Association, he said, has a much larger field of work, and it will require in the future the expenditure of more energy, more time and more money if the greatest results from this fertile field are to be produced. The Claim Agents, Accountants and Engineers, to a large extent, are consumers of gross earnings. The Transportation and Traffic men are primarily the producers of gross earnings. Since the organization meeting it has been a pleasure to devote considerable time to the work of this association.

Mr. Allen is convinced that the best results will be produced by committee work. It is not intended that committee work shall be confined to a meeting of the committee once or twice during the year, but by committee work is meant the study and knowledge of conditions existing in the various properties of the member companies, the reduction of these conditions to a fair statement in writing, the remedy which should be applied to reconcile abnormal conditions, in so far as is practicable, and the recommendation by the committee of a practical application that will meet transportation and traffic conditions, and perfect street railway service for its patrons, with all that that perfection may mean.

President Allen's address was greeted with enthusiasm, and the secretary read the report of the organization meeting.

The president called for a vote on this report, and stated that if there were no recommendations or exceptions, it would be received and printed in the official proceedings.

John I. Beggs, of Milwaukee, Wis., took some exceptions to several points in the constitution, particularly as regards the matter of eligibility for voting. The paragraph to which Mr. Beggs took objection read: "Each active member shall be entitled to one vote on all questions coming before this association, which shall be cast by a properly accredited representative of its transportation or traffic department." The point was raised that it might not be convenient at all times to have in attendance a representative of the traffic department. In this case there would be no opportunity for a duly accredited officer of the company not a representative of the traffic department to cast the vote for his company.

Mr. Allen said that the points which had been raised by Mr. Beggs should receive careful and serious consideration, and it was finally decided to refer the portions of the constitution and by-laws under discussion back to the committee, with a request that they be given consideration and a further report made.

The report of the executive committee was presented by the secretary. This was accepted, and will be published in the proceedings.

The report of Secretary Swenson covering the period to September 30, 1908, was presented. This report was accepted.

The paper entitled "How Can a Small Road Best Promote Traffic and Increase Its Revenue?" by Ernest Gonzenbach, general manager of the Sheboygan Light, Power and Railway Company, Sheboygan, Wis., was read by J. H. Pardee. This paper was discussed by Messrs. Sylvester, Hegarty, Passailaigue, Gossler, Davis, Pardee, Allen, Dozier, Beggs and Parker.

The meeting was then adjourned to reconvene the next morning.

The Transportation and Traffic Association held further meetings on Tuesday, Wednesday and Thursday. The meetings of the American Association were held on Tuesday afternoon and Wednesday and Thursday afternoons. The meetings of the Engineering Association were held on Tuesday, Wednesday and Friday afternoons and Wednesday morning. The meetings of the Claim Agents' Association were held on Monday and Tuesday afternoons and on Tuesday and Wednesday mornings. The Manufacturers' exhibit was particularly comprehensive and covered the entire expanse of Young's million-dollar pier.

CHILE HYDROELECTRIC PLANT ON THE RIO LOA.

BY FRANK KOESTER.

For the extraction of saltpetre a hydroelectric plant has been installed some eleven miles north of Rica Aventura, utilizing the water of the Rio Loa in the northwestern part of Chile, South America. In this vicinity the saltpetre is found under a layer of gypsum about ten feet thick. The saltpetre is extracted by dynamiting, then transported to the "Oficinas" where it is treated for commercial use.

Prior to the present hydroelectric installation there was a steam-operated plant in connection with which is a 2,000-volt transmission line. Owing to the high cost of the transportation of coal, it proved a poor financial proposition. The steam plant is now used as a reserve.

For utilizing the water of the Rio Loa a comparatively small dam only had to be built across the river. The power plant is located a short distance down stream, as seen in Fig. 1, and has a head varying from eighty-two to 102 feet. It has been designed to accommodate four units, three of which are at present installed, each having a capacity of 455 horse-power at 5,000 volts.

It will be noticed in the accompanying illustration that the complete machinery and also the switchboard were installed before the erection of the superstructure. This was done under the certainty that there would be no rain during that season of the year.

The substructure is made up of rough-faced stone while the superstructure is of a wooden-frame skeleton and brick, the interior being cement plastered, while the floor is tiled. The switchboard itself is located on a raised platform, while the switch gear is housed in a two-story wing. The generating room is served by a hand-operated traveling crane.

The turbines are the inward-flow Francis type and are connected by means of an isolated flexible coupling to a three-phase generator. Between the coupling and turbine is a heavy flywheel to take up fluctuations caused by the cutting of

FIG. 1.—PLANT ON THE RIO LOA, NEAR AVENTURA, CHILE.

FIG. 2.—HYDROELECTRIC PLANT NEAR AVENTURA, ON RIO LOA, SHOWING METHOD OF CONSTRUCTION.

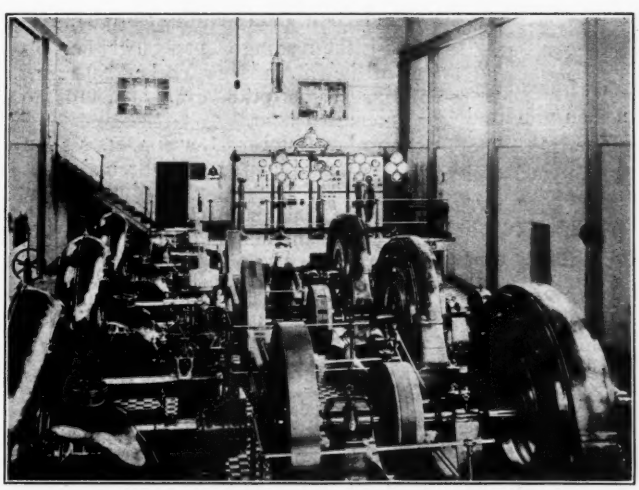


FIG. 3.—INTERIOR OF POWER PLANT NEAR AVENTURA, ON RIO LOA, CHILE.

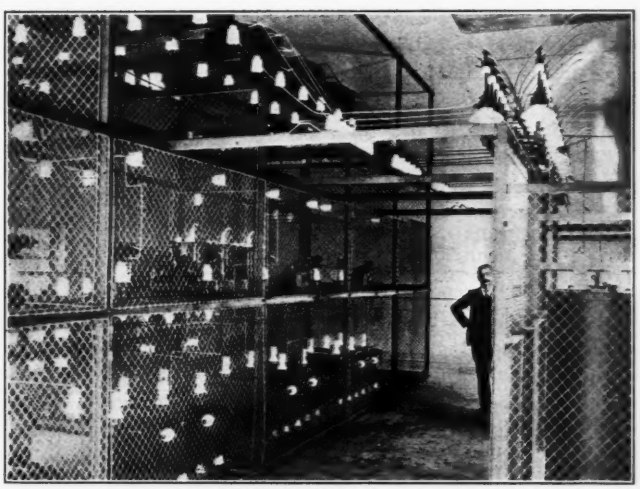


FIG. 4.—HIGH-TENSION SWITCHING COMPARTMENT, HYDROELECTRIC PLANT ON RIVER LOA, NEAR AVENTURA, CHILE.

motors in and out in the various "Oficinas."

Each generator unit has its own exciter mounted on the overhang of the shaft. The generator leads run through trenches to the switchboard. The latter is of ornamental-iron design faced with white marble slabs, there being four panels. In front of the switchboard are five instrument columns, one for each generator unit, and one master control.

The power is distributed by a 20,000-volt transmission line a distance of thirteen miles to the substations at Rica Aventura, Grutas and Empresa, while a fourth substation at Prosperidad is now under construction.

The first section of the conductor is twenty-five square millimetres, the remaining section is sixteen square millimetres. They are carried on wooden poles of a rectangular cross-section.

The line is well protected by lightning arresters and automatic circuit-breakers, the latter being electrically controlled. The lightning arresters consist of a series of horn-gaps, Fig. 4, choke-coils, fluid rheostats and water flow grounds.

The plant was designed and constructed by the Siemens-Schukert Werke, Berlin, who also furnished the above-mentioned steam-power plant.

FINANCIAL REPORTS OF ELECTRICAL COMPANIES.

INTERNATIONAL RAILWAY OF BUFFALO.

The International Railway Company, of Buffalo, N. Y., reports to the Public Service Commission at Albany, for the year ended June 30, 1908, as follows: Gross operating revenue, $4,702,850; operating expenses, $2,751,335; net operating revenue, $1,951,515; taxes, $244,682; operating income, $1,706,833; non-operating income, $26,065; total income, $1,732,898; fixed charges, $894,397; net corporate income, $838,501.

KANSAS CITY RAILWAY AND LIGHT.

The Kansas City (Mo.) Railway and Light Company's report for August and three months, June 1 to August 31, is as follows: August gross, $537,499; expenses, $306,609; August net, $230,890; taxes and interest, $155,540; August surplus, $75,350, comparing with $104,505 for the same month last year. Three months' gross, $1,576,542; expenses, $922,907; three months' net, $653,735; taxes and interest, $465,349; three months' surplus, $188,386, as against $279,151 for the corresponding quarter of 1907.

PORTO RICO RAILWAYS COMPANY.

The report of the Porto Rico Railways Company for the month of August is as follows: August gross, $35,427; expenses, $21,385; August net, $14,042, as compared with $12,760 for August of last year.

Allis-Chalmers Company Issues Favorable Report.

In the annual report of the Allis-Chalmers Company, which was made public last week, President W. H. Whiteside shows that the operating profits for the year ended June 30, 1908, amounted to $2,573,961, or more than double those of 1907. At the same time there was a surplus after all charges of $385,997, comparing with a deficit last year of $229,817. In his remarks to stockholders President Whiteside says:

"Noteworthy success has been obtained in the sale and operation of our new lines of production, namely, gas engines, steam turbines, hydraulic turbines and electrical apparatus, which are now among the standard products of our company. The extended use of these lines of production, often in connection with our older products, not only by purchasers who have long been our regular customers, but by numerous new customers in almost all classes of industry, forms the basis for an increasing and profitable business."

The detailed income account for the year, with comparisons, follows:

	1908.	1907.
Profit on operation....	$2,573,961	$1,226,242
Maintenance, depreciation, interest, etc...	1,958,147	1,613,540
Net profit for year...	$615,814	*$387,298
Previous profit and loss deficit.....	229,817	+157,481
Surplus.....	$385,997	*$229,817

*Deficit. +Surplus.

The item, profits on operation, as above, is after deducting expenses of manufacturing and selling; dividends on preferred stock of the Bullock Manufacturing Company and ordinary provision for doubtful accounts.

The surplus profits for the year, $615,814, as above, are equal to 3.81 per cent earned on the $16,150,000 preferred stock.

The report adds: "Inasmuch as owing to present financial conditions there may possibly be a shrinkage in the collection of certain bills receivable, it has been deemed advisable to set aside out of profits a special reserve of $60,000 shown above. Beginning with the second quarter and continuing for half the company's fiscal year, owing to the severe contraction in general business throughout the country the volume of the company's sales averaged about one-half of normal. During the last quarter there was a gradual and steady increase in orders booked."

The balance sheet shows reductions in the inventories amounting to $2,518,841; increase in notes and accounts receivable of $272,137; increase in cash of $1,059,300, and decrease in accounts and notes payable amounting to the substantial sum of $2,304,413. These changes, together with the net profit on the operations of the year not used for additions to plant and equipment, considerably strengthen the position of the company and increase its working capital.

American Electrochemical Society.

A meeting of the American Electrochemical Society will be held in New York city, October 29, 30 and 31. Headquarters for registration and information will be established on Thursday evening, October 29, at the Hotel Cumberland, Fifty-fourth street and Broadway. On Friday morning and afternoon headquarters will be established in the Chemistry Building of the College of the City of New York. On Saturday, October 31, the meetings will be held at the Chemists' Club. The following programme has been announced:

Thursday, October 29, at 8 P. M., meeting of the board of directors at the Chemists' Club.

Friday, October 30, at 9 A. M., meeting at the Doremus Lecture Theatre, Chemistry Building, College of the City of New York, for reading and discussion of papers; 12.30 P. M., luncheon, by invitation of the staff of the department of chemistry, College of the City of New York, Alumni Hall, main building; 2 P. M., session for the reading of papers, at the College of the City of New York; 7.30 P. M., informal subscription dinner—details to be announced later.

Saturday, October 31, at 9 A. M., session for reading of papers and discussion, at the Chemists' Club; 1 P. M., luncheon at the Hotel Cumberland; 2 P. M., inspection trip—to be announced later; 8.30 P. M., smoker at the Chemists' Club.

Electrical Engineer, Technologic Branch, United States Geological Survey.

The United States Civil Service Commission, Washington, D. C., announces an examination on November 9 to secure list of eligibles from which to make certification to fill a vacancy in the position of electrical engineer in the technologic branch of the United States Geological Survey, at a salary ranging from $1,620 to $3,000 per annum, according to the rating received; and vacancies requiring similar qualifications as they may occur. Applicants should at once apply to the United States Civil Service Commission, Washington, D. C., for application form 304 and special form.

HIGH-POTENTIAL UNDERGROUND TRANSMISSION.[1]

BY P. JUNKERSFELD AND E. O. SCHWEITZER.

From present indications systems operating at potentials of 100,000 volts and over will not be uncommon in a few years, and none dare prophesy what further increase the future has in store.

Within the confines of the largest cities the conditions are sometimes such that it is not advisable to carry these high potentials overhead. In such cases it may be necessary to place the conductors underground. The limitations of insulation and size have kept the transmission voltage for underground cables at about one-third that of overhead transmission, and while there has been a considerable advance in the art the approximate ratio of 1 to 3 seems still to be maintained. However, in large systems of underground transmission, insulation and size are not the only cable limitations. The line-constants may become such that the cable is frequently subjected to dangerously high potentials.

This paper will not deal with experience at pressures lower than 5,000 volts. A typical system using high-potential underground transmission extensively is that of the Commonwealth Edison Company, of Chicago, and its experience will be cited principally. Suffice it to say that at present (September, 1908) the system consists of two generating stations (a third is in process of erection) with a maximum capacity of about 18,000 kilowatts and 100,000 kilowatts, respectively, sixty-six 9,000-volt, three-phase transmission lines aggregating 272 miles, supplying forty-four substations containing synchronous converting equipment almost exclusively. Three additional substations and sixty-eight miles of additional 9,000-volt cable are now under construction.

There is also a 20,000-volt line eleven miles long connected to the 9,000-volt system through step-up transformers and feeding railway and frequency-changer substations located in an outer or suburban zone. Forty-four miles of additional 20,000-volt underground lines are under construction, which will bring the total up to fifty-five miles. The entire cable system is shown in Fig. 1. This

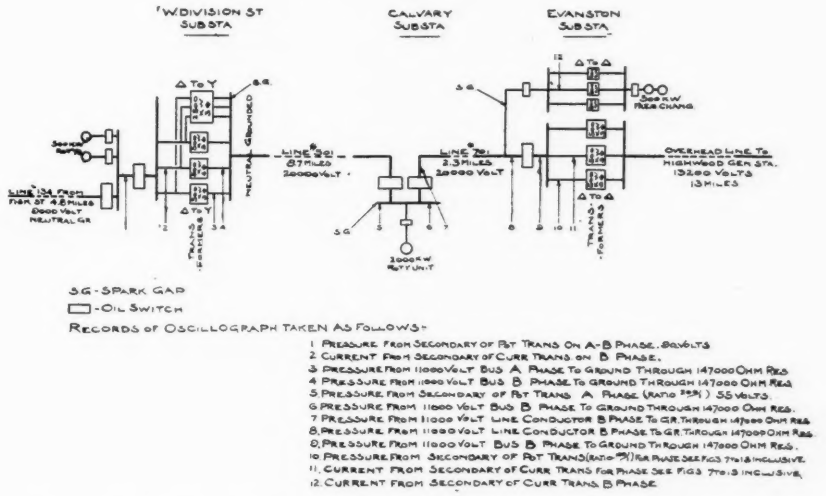

W. DIVISION ST SUBSTA
CALVARY SUBSTA
EVANSTON SUBSTA
SG-SPARK GAP
-OIL SWITCH
RECORDS OF OSCILLOGRAPH TAKEN AS FOLLOWS:-
1. PRESSURE FROM SECONDARY OF POT TRANS ON A-B PHASE. 80 VOLTS
2. CURRENT FROM SECONDARY OF CURR TRANS ON B PHASE.
3. PRESSURE FROM 11000 VOLT BUS A PHASE TO GROUND THROUGH 147000 OHM RES.
4. PRESSURE FROM 11000 VOLT BUS B PHASE TO GROUND THROUGH 147000 OHM RES.
5. PRESSURE FROM SECONDARY OF POT TRANS. A PHASE (RATIO 75/1) 55 VOLTS.
6. PRESSURE FROM 11000 VOLT BUS B PHASE TO GROUND THROUGH 147000 OHM RES.
7. PRESSURE FROM 11000 VOLT LINE CONDUCTOR B PHASE TO GR. THROUGH 147000 OHM RES.
8. PRESSURE FROM 11000 VOLT LINE CONDUCTOR B PHASE TO GR. THROUGH 147000 OHM RES.
9. PRESSURE FROM 11000 VOLT BUS B PHASE TO GROUND THROUGH 147000 OHM RES.
10. PRESSURE FROM SECONDARY OF POT TRANS (RATIO 75/1) FOR PHASE SEE FIGS 7 TO 18 INCLUSIVE.
11. CURRENT FROM SECONDARY OF CURR TRANS FOR PHASE SEE FIGS 7 TO 18 INCLUSIVE.
12. CURRENT FROM SECONDARY OF CURR TRANS B PHASE.

FIG. 1.—SUBSTATION CONNECTIONS OF 20,000-VOLT LINE, SHOWING POINTS AT WHICH OSCILLOGRAMS WERE OBTAINED.

20,000-volt system will be permanently supplied from 5,000-kilowatt, three-phase, step-up transformers connected delta to star with the neutral grounded. The standard size of 20,000-volt cable is 00, and of 9,000-volt cable 0000 and 250,000 circular mils.

In February, 1902, the twenty-five-cycle, three-phase system of about seventeen miles of three-conductor cable and seven synchronous converter substations was raised from 4,500 to 9,000 volts, the equipment and cable having been installed with this change in view. This transmission system was first put into service in August, 1897. The greater part of the cable at the time of the change to 9,000 volts was 00, some 0 and about one-fifth of 0000 size. The insulation on the original 4,500-volt cables consisted of five-thirty-seconds-inch inner wall of paper around each conductor and an outer wall of three-thirty-seconds inch thick surrounding all three. The thickness of the lead sheath was one-eighth inch. In the 9,000-volt cable the thickness of the paper insulation was finally standardized at six-thirty-seconds inch and four-thirty-seconds inch, respectively.

The early experience in Chicago and elsewhere showed the necessity for avoiding sharp bends and for using extreme care in making the splices. A small number of burn-outs occurred during the first year's operation at 9,000 volts, and nearly all were due to sharp bends or to moisture at the joints. In order to determine how quickly moisture in a cable causes a breakdown, after it has entered through an opening in the sheath, in 1903 Mr. Burch,[1] of Minneapolis, made some interesting experiments. He found that it usually requires from a day to a week for the moisture to work down sufficiently to cause a burn-out. Paraffin had, up to this time, been used at the joints and in the terminal bells, but being hygroscopic in effect, due to voids left after cooling, it was not satisfactory at the higher voltage. About this time some of the engineers of the company, after considerable study and experimentation, developed a high-grade insulating compound which since then has been used exclusively on all high-potential work.

The splices are made up with great care and the compound is poured into the sleeve at a temperature of 150 degrees centigrade in a manner to exclude all moisture. The success of this work is evidenced by the fact that there have been but two failures in splices during the last five and one-half years and there are now some 3,400 splices in the high-tension system. The compound-filled terminal bells were formerly made of brass cylinders with a cast-brass base, a substantial ground connection being made at the base. On some recent work a few bells made of a special impregnated concrete have been used with very satisfactory results. The proper protection of cables against damage due to burn-outs of adjacent cable has received considerable attention, and all cables in manholes are covered with split vitrified-clay tile cemented in. Entirely separate duct lines, either on different streets or on opposite sides of the same street, are provided so as to divide the energy along different routes when possible, so that all important substations have at least two lines, each of which follows a different conduit route.

Semi-annual potential tests were made at the beginning but were discontinued

[1] A paper presented at the 230th meeting of the American Institute of Electrical Engineers, New York, October 9. Abridged.

[1] Burch, A. I. E. E. Trans. 1903, page 433.

when the system became more extensive. The danger and liability of accident from these frequent high-potential tests were thought to more than offset the doubtful advantages derived. Since then testing has been limited to new, altered or repaired cable which, before being put into service, is subjected to a test of double working voltage for one minute.

The record of cable trouble for the last five and one-half years' operation shows that failure of cables thus far has really not been a very serious matter. The line-protecting devices are now so perfected that a cable burn-out causes little disturbance. Of the total of forty-four cases recorded only four seriously disturbed the system, and each one of these was aggravated by faults in the protective relays.

On the 20,000-volt line in Chicago, which has now been in service about fifteen months and which was an initial installation at this higher pressure, there have thus far been a total of four burn-outs, one of which was due to a mechanical injury, one to moisture in a poorly made joint, and two were in the cable itself.

It will be seen, therefore, that the experience with high-potential cable has not been such as to cause alarm. The most frequent sources of trouble are from without, and of these electrolysis is apparently the most persistent. However, with rapidly growing systems the destructive effect and danger of breakdowns tend constantly to increase, and it becomes advisable to forego complacency for a while and to look into the system with inquisitive eyes to see just what is going on.

It was this desire to know more about possible dangerous potential rises so that proper safeguards against them could be provided, if found necessary, that led the Commonwealth Edison Company to undertake a series of spark-gap and oscillograph investigations, the principal results of which thus far obtained are described in this paper. A further purpose of the tests was to obtain information regarding these high-voltage systems for use in their further development. The investment required for such 20,000-volt and higher transmission-cable system is very large; it, therefore, becomes all the more imperative to know that such investment is a safe one commercially.

About a year ago a series of oscillograph tests was started on the 9,000-volt system to determine whether or not resonance existed in any part of it, or if dangerous potential rises occurred from any other cause. The oscillograms obtained were taken at the Fisk street station and included current and pressure waves for all principal switching operations, as well as several for a special cable connection in which resonance was sought. None of the records showed any appreciable excess voltage.

These investigations were later continued and expanded but no dangerous rises were found. Spark-gaps were installed at four different points of the system and their record carefully kept. The gaps consisted of needle points in series with which are resistance and fuse. They were connected between each phase and ground. These spark-gaps showed that there are frequent rises of about seventy per cent and occasionally ones of about 100 per cent which apparently have no connection whatever with any switching. These occurred at the station and also in remote substations. At times of cable breakdown, one or more of the spark-gaps invariably discharged at double potential.[1] With grounded systems cables break down first between a phase conductor and ground. When the protective devices fail to act properly, as they did occasionally before recent improvements were made,[2] the arc continues until it is communicated to one or both of the other phases. The effect on the system is then far more severe. Such occurrences were, however, the exception rather than the rule. When, during a breakdown, one or two of the spark-gaps discharge it is on the phase or phases other than the one on which the burn-out occurs. Sometimes all three of the gaps discharge during cable trouble, but not simultaneously. It is quite probable that the potential rises evidenced by these discharges are due to magnetic effect in the generators as much as to surges in the cables. There was only one case of cable breakdown which seemed clearly the result of a surge. During some arrangements which were being made at the Fisk street station to put a potential test on a bus-bar, one of the test leads accidentally came in contact with a live switch stud, the door over which had been opened. This grounded one phase of the system through fifty feet of heavily insulated No. 12 wire in series with the high-tension coil of a dead 150-kilowatt testing transformer. The heavy insulation was punctured in a number of places and the entire fifty feet of test conductor was vaporized. No other damage was done in the station. A few seconds later one of the cables burned out at a point about one mile from the station.

The net result of this investigation indicates that at the present time the 9,000-volt system is reasonably free from dangerous conditions as far as destructive potential rises are concerned. It also indicates the advisability of continuing to make tests on newly installed or repaired cable at double potential for one minute.

Attention was then turned to the new 20,000-volt line in the attempt to learn what difficulties are to be met with there. On the diagram of this line in Fig. 1 are shown the locations at which current and pressure connections were made for the oscillograph. The numerals on the oscillograph refer to the corresponding ones of Fig. 1. Spark-gaps were connected to ground at points marked s.g. These spark-gaps were first installed in the Evanston substation at the end of the line and originally set at 1.1 inch, corresponding to 21,700 volts. During fifteen days A phase discharged eight times, B phase five times, and C phase six times. Five times during this period two gaps discharged at the same time (four on B and C and one on A and B). All other discharges were on one phase at a time. On only one day were there more than one discharge per phase, and on that day B and C phase gaps discharged together twice, the interval between the discharges being eighteen minutes. With the exception of a single discharge on A phase, none of the discharges could be connected with any switching or other apparent source of disturbance. In this single case a heavy lightning storm passed over the overhead transmission line which is fed through transformers from the 20,000-volt line. It seems probable that a static charge passed from the line into the transformer and caused the rise which discharged on the A phase gap. Fourteen days' experience with a gap of 1.15 inch (22,500 volts) showed seven discharges on A phase, six on B, and five on C. The only coincident disturbances were as follows: one discharge on A phase when a steam-driven generator at the Highwood station was "synchronized"; B and C phases discharged together when a steam-driven unit in parallel with generator or frequency changer in Evanston governed poorly causing heavy cross-currents; one discharge on A phase when a steam-driven unit was disconnected at Highwood, and one discharge on B phase when steam-driven unit was shut down in Evanston. With the setting increased to 1.2 inches

[1] Double potential when units with no neutral resistance were grounded and about 130 per cent over potential when neutral was grounded through resistance (R = 2.6 ohms).

[2] June paper A. I. E. E., Chicago, R. F. Schuchardt.

(23,300 volts) there were only five discharges recorded in four months, one on A phase, two on B phase alone, and one on B and C phases together. The simultaneous discharge on B and C phases occurred during a burn-out of the line, probably a breakdown of A phase to ground. One of the B phase discharges took place when a connection between the 9,000-volt coils of the C phase transformer at Division street burned out. A further increase in gap setting was made to 1.25 inches and left for six weeks, during which time A phase discharged when the line broke down. B phase also discharged, but the connection with a disturbance could not be learned. A final increase to 1.3 inches was made. This corresponds to 25,000 volts. During three months there was one discharge on A phase and two on C phase, but here again no cause for the potential rises could be ascertained. Spark-gaps were also installed at the step-up end of the 20,000-volt line in the West Division street substation during a test at that point. They were set at 1.1 inches and during the few hours that they were connected each of the phases discharged heavily at different times. Recently spark-gaps were installed at the Calvary substation. They are set at 1.1 inches and each phase has discharged heavily at times.

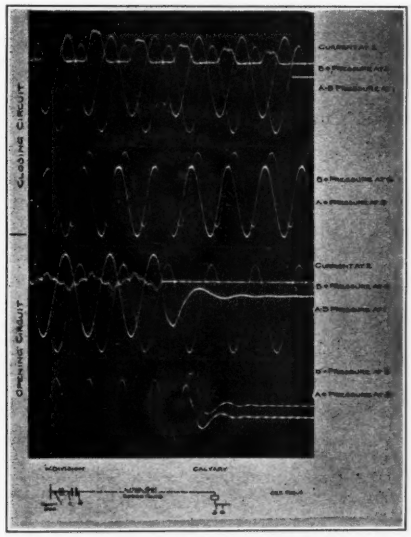


FIG. 2.—CLOSING AND OPENING LINE NO. 501.

An attempt was made with the oscillograph to determine the relation between the potential rises and operating conditions. The oscillograph was connected at various times at the three switching points of the line and some records were obtained for switching operations. Unfortunately the time during which the line could be kept out of service for these investigations was so limited that only a few records could be obtained for each operation. It is recognized that in such a limited number (and especially where, as in most cases, only one phase pressure could be recorded) many disturbances may have escaped detection. However, many of the curves are of considerable interest and may serve to bring out more discussion. A number of them are, therefore, included in this paper. It will be noted that none of the oscillograms shows potential rises as high as those recorded by the spark-gaps. Had more oscillograms been taken, or had all phase pressures been recorded simultaneously, higher rises might possibly have been observed. However, the function of the spark-gap is clearly to detect high potentials, while that of the oscillograph is to show the character of the disturbance and its duration. The spark-gap watches the line continuously while the oscillograph records occurrences for but very brief intervals.

In these figures the source of energy is always from the left, the opening or closing operation being performed on switch marked S. There being but one oscillograph and no pressure wires available, the records at the different substations were not taken simultaneously. The apparatus was set up at one place and curves were obtained for the various operations. The apparatus was then moved to the next substation and the operations were repeated.

Fig. 2 is for closing and opening line No. 501. The current wave in the upper curve is the characteristic exciting current wave of a transformer when first energized. The logarithmic curve due to hysteresis is clearly shown. The dying of the pressures in comparatively slow oscillations when the line and transformers are disconnected is shown in the lower curves.

The curves in Fig. 3 are for closing and opening the entire eleven miles of 20,000-volt line from Division street to Evanston.

Fig. 4 shows curves for closing dead transformers on to a live bus-bar. The first rush of current in this case was nearly six times full-load current. An interesting curve is the one for West Division street showing the duration and amount of the current rush. The curve obtained on opening the switch to the transformers is also given.

The motor of the frequency-changer set at Evanston is wound for 9,000 volts, the line pressure being stepped down in three 200-kilowatt transformers. In Fig. 5 are shown curves obtained when closing these transformers to a live bus-bar. In the upper curve the transformers had previously been demagnetized by keeping them connected to the motor while being shut down until it had come to rest, the fields being kept excited. In the lower curve they had been disconnected at full pressure. The difference in current rush emphasizes the advisability of keeping the transformers connected to a dying machine when shutting down. This applies also to transformers of synchronous converter sets.

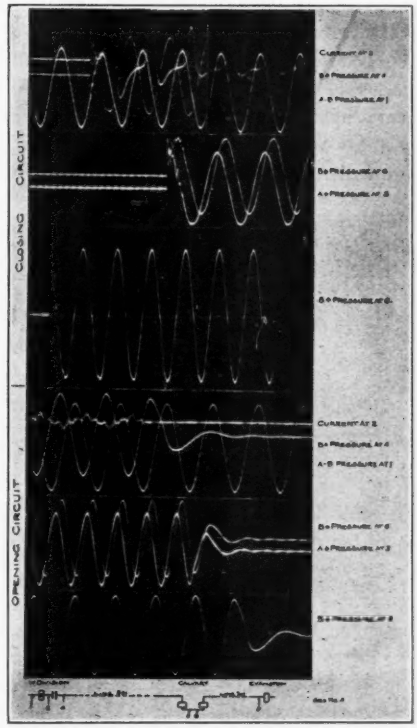


FIG. 3.—CLOSING AND OPENING THE ENTIRE ELEVEN MILES OF 20,000-VOLT LINE.

The curves for starting the frequency-changer set from these transformers show no potential disturbance.

At the Evanston substation there are three 200-watt potential transformers connected in star with their neutral grounded on both primary and secondary. It will be remembered that the 20,000-volt line is grounded solid at the Division street transformers but at no other point. The oscillograph was placed in the neutral connection to ground of the Evanston potential transformers' primary and a current of seventy-six milliamperes was obtained, this amount remaining unchanged even when a resistance of 10,000 ohms was placed in series with the ground con-

nection. The impedances of the three transformers have not been measured but their load is not balanced. In Fig. 6 this current wave is shown taken simultaneously with pressure. The wave for phase-to-phase pressure shows an unstable condition.

From the spark-gaps on the 20,000-volt line we learn then that pressure-rises in excess of 100 per cent occur occasionally. The oscillograms thus far obtained give no clear evidence of the cause, but the cable broke down three times in fifteen months—two of these times in the cable itself, either as a result of these rises or of weakness developed by mechanical stresses imposed upon the cable at the time of installation. This record is reasonably satisfactory, as during the first year's operation we must expect to eliminate the weakest points. The second 20,000-volt line which will complete this

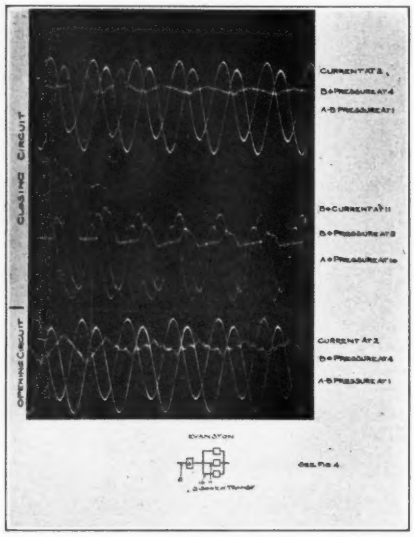


FIG. 4.—CLOSING DEAD TRANSFORMERS ON TO A LIVE BUS BAR.

northern ring is being installed at the present time. After it is put in service the investigation will be repeated. The spark-gaps are kept in service continuously. If dangerous potential rises still exist the remedy will be applied which, in the form of the aluminum arrester, is fortunately at hand. It is, therefore, quite prudent to state that 20,000 volts is a safe pressure for an underground system. Whether a higher voltage will be possible is a matter which has received and is receiving considerable attention.

SUMMARY.

From the viewpoint of the investor or operator the state of the art regarding high-tension underground transmission might be summarized as follows:

1. Underground cable systems of 11,000 volts and under, if properly made, installed and operated, will give at least equally and probably more reliable service than most of the other elements in the electric power system of which the cable system is a part.

2. Where local and commercial conditions justify, pressures as high as 25,000 volts can be satisfactorily used even for systems aggregating as much as a hundred miles of cable. No single line of such a system would be much longer than twenty miles. If higher voltages are needed to meet operating requirements, and can be justified commercially, special construction will be necessary to overcome limitations in paper, rubber or varnished cambric insulation, and also in the standard forms of underground conduit or subways used in this country.

3. On comparatively short lengths, underground or under water, as a part of a long overhead transmission line, cables operating at 40,000 volts can be used.

4. Potential rises of fifty per cent and 100 per cent are not uncommon in large underground cable systems, although this fact may not always be manifest, due to high factor of safety.

5. Definite knowledge of what actually occurs in large high-potential underground systems is still meager, especially regarding intensity and frequency of surges, heating effects and critical temperature for various kinds and thicknesses of insulation, corona effects and similar matters.

In conclusion we would urge all companies having high-potential cable systems

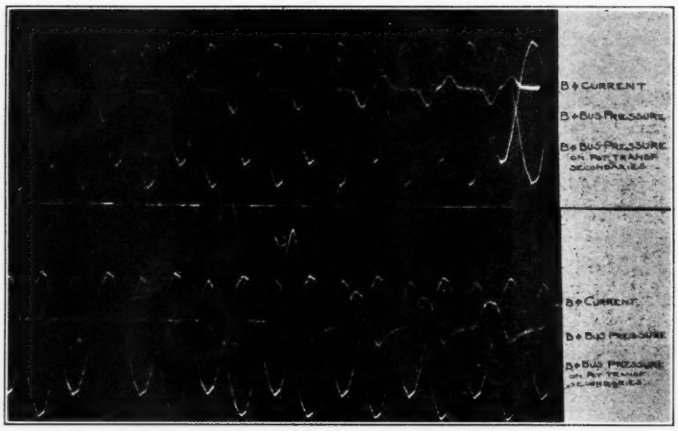


FIG. 5.—CURVES OBTAINED WHEN CLOSING 200-KILOWATT TRANSFORMERS ON TO LIVE BUS-BAR.

to keep a complete and systematic record of all troubles. To quote Dr. Steinmetz:

"To determine the origin and cause of high-voltage disturbances, so as to be able to guard against their recurrence, the most important thing seems to be to very carefully observe and record all the details of the phenomena, even those which appear unessential. The existence of static on switchboards, lines, etc., and the existence of voltages and currents different from those which may be expected, require special attention. Either of these is sufficient to raise the suspicion of some dangerous fault in the system or some dangerous arrangement of apparatus, which requires consideration. . . . The severity of the phenomena depends almost entirely upon the power momentarily available in the system and

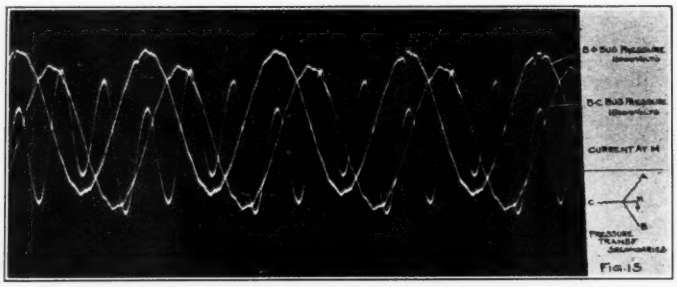


FIG. 6.—CURRENT WAVE TAKEN SIMULTANEOUSLY WITH PRESSURE.

very rapidly increases with the size of the generating stations. With the increasing power and extension of electric systems we must expect to see these disturbances increase in destructiveness. The prospect which this holds out for the future is not very agreeable; it shows, however, the increasing importance for the operating engineer to study and become familiar with the subject so as to be able to cope with the problems which are before him, which perhaps are the most serious in the field of electrical engineering. . . . It would, therefore, be a great help if a far closer interchange of experience existed between different operating engineers."

May we not urge on all engineers to remember these words and to appreciate how, by following Dr. Steinmetz's bidding, we all can help to advance the art?

ADDENDUM.

Spark-Gaps—In using spark-gaps as a means for measuring potentials, certain precautions must be taken to insure reliable results. This fact is, of course, well known. The spark-gaps mentioned in the paper were made up on the usual insulated standard and provided with ordinary No. 5 sewing needles. The series resistance consisted of carbon rods of an amount to limit the current to about one-half ampere at normal pressure. In order to get the correct interpretation for the various settings, the conditions of humidity and temperature of the places where the spark-gaps were installed were duplicated in the laboratory and the gaps were repeatedly calibrated from 0.4 to 1.3-inch gap. Within this range they were found to agree to within about two per cent of the Institute standardization rules. It is safe to assume then that the indications recorded in the paper are correct within five per cent, which is well within the accuracy required for this work.

Where the spark-gaps are in continuous service, to detect occasional high rises it is necessary either to renew the needles daily or to brush the points frequently to avoid an accumulation of dust which would alter the effective gap distances. Any tight enclosure around the gap to prevent this accumulation would introduce errors due to the ionization of the enclosed air. During a discharge the needle points burn to a bead, the size of this bead being an index of the severity of the discharge, and thus roughly of the intensity of the disturbance at that point. A recording meter is placed in series with the gaps to record the time of the discharge.

Oscillograph—The development of a successful portable oscillograph marked an important step in the development of cable systems. It afforded a means for studying the system analytically, so that causes for possible unstable conditions could be determined and guarded against. In the particular application of detecting voltage rises of short duration its usefulness, while still very great, is more limited. The time-interval, already mentioned in the paper, introduces an external limitation. The limitations of the apparatus itself are principally as follows:

1. The free periodicity of the vibrators is less than that of some occasional waves of very short length. In the oscillograph used in the test the vibrators were adjusted for their highest free periodicity, about 6,000 cycles per second. Any peak having a periodicity higher than this would not be correctly recorded. However, a peak of such extremely short duration would have too little energy to cause a harmful disturbance and would thus be of little interest.

2. The vibrator can not be made absolutely dead-beat, but fair results are obtained with five parts of castor oil and one part of turpentine as the damping medium.

3. The self-induction of the vibrator circuit is not entirely *nil*, but is sufficiently low to be practically negligible.

4. The sensitiveness of apparatus can not be made perfect, and its degree of perfection in this regard determines the degree of accuracy of its indications. The amperes per millimetre of deflection of the three vibrators used is from 0.00518 to 0.00578.

While in these four important qualities the oscillograph does not attain the ideal, yet for all practical purposes the apparatus is quite satisfactory. The limited time-interval of application is the most serious shortcoming, and probably the cause for the absence of double-potential peaks on the curves. A great number of oscillograms could be taken, and yet none of them happens to coincide in time with a high peak. This was actually the case in the tests made, during which there was never a spark-gap discharge simultaneous with the taking of an oscillogram.

Reports to the recent meeting in Chicago of the Western division of the American Association of Railway Telegraph Superintendents indicate that within the last two years over 6,000 miles of railroad have been placed under telephone operation.

THE ELECTRICAL FEATURES OF THE GARY (IND.) PLANT OF THE INDIANA STEEL COMPANY.

BY C. A. TUPPER.

The Indiana Steel Company has secured a site of 9,000 acres, with a lake frontage of one and three-quarter miles, on which to erect its steel mills and a residence city for its employés, twenty-three miles east of Chicago, at a point in northern Indiana where the Grand Calumet flows into Lake Michigan. This is the town of Gary, Ind., the like of which exists nowhere else in the world.

The unique and, to engineers, the inspiring feature of this great steel works is the utilization of the entire production of gas from the blast furnaces for useful service in operating blowing engines and in furnishing the source of power for gas engines driving alternating and direct-current dynamos, generating current for light and power.

Eight blast furnaces have thus far been erected, and there are two blowing-engine houses of similar construction to the power-house which contains the electrical machinery. One of the blowing-engine houses is 600 feet long and 104 feet wide. The other is of the same width, but only 530 feet long. The first-named house includes a central pumping and hydraulic power plant equipped mainly by the Snow Steam Pump Works, of Buffalo, N. Y. Besides gas engines, each house contains two steam-driven Tod blowers, but when the plant is in full operation these will not be used. The initial equipment of the plant calls for sixteen blast furnaces. These will produce about 44,900,000 cubic feet of gas per twenty-four hours, equivalent, when used in gas engines, to 500,000 brake-horse-power. Of this quantity approximately thirty per cent is taken for heating the stoves, seven and one-half per cent is diverted to steam-boiler furnaces, five per cent is consumed by various auxiliaries or lost in the process of cleansing, twelve and one-half per cent operates the gas-engine-driven blowers and forty-five per cent supplies the electrical power station.

Each of the sixteen blowing engines consists of a horizontal twin-tandem gas engine of 2,500 horse-power. Eight of the engines were built by the Westinghouse Machine Company and eight by the Allis-Chalmers Company. The power station is 966 feet long and 105 feet wide, with forty-two twenty-three-foot bays. It is located adjacent to the blowing-engine houses and between the blast and open-

hearth furnaces. In this station there are installed seventeen horizontal twin-tandem double-acting gas engines running at eighty-three and one-third revolutions per minute. Fifteen of these engines are designed for coupling to alternating-current generators, and two will be connected to direct-current generators. The alternating-current machines are for twenty-five cycles, three-phase, 6,600 volts. The direct-current machines operate at 250 volts. The seventeen generators were built by the Allis-Chalmers Company.

The alternating-current generators are of a type developed by the Allis-Chalmers Company for use with these engines. The laminated stator core is held in a heavy box yoke designed to allow full circulation of air around all parts. The core punchings are held in place by means of dovetails and the armature windings are placed in open slots in the inner periphery of the stator core. The coils are held firmly in place by wedges and, on account of the open-slot construction, can be readily replaced in case of damage. The field poles are mounted on a cast-iron spider and so arranged that they can be removed; the exciting coils are of copper strip wound on edge.

The revolving fields are special in construction, with field poles of solid cast steel bolted to a heavy cast-iron spider; they can, therefore, be readily removed in case it is necessary to get at a field coil. The field-windings are held in place partly by the projecting pole tips and partly by brass rings running completely around the rotor on each side and fastened to the top of the poles by long brass screws. The construction, combined with the solid poles, gives a large damping effect, prevents hunting and aids in securing parallel operation.

The direct-current generators have also been designed with particular regard to this service, but in general are similar to the Allis-Chalmers Company's standard engine-type machines.

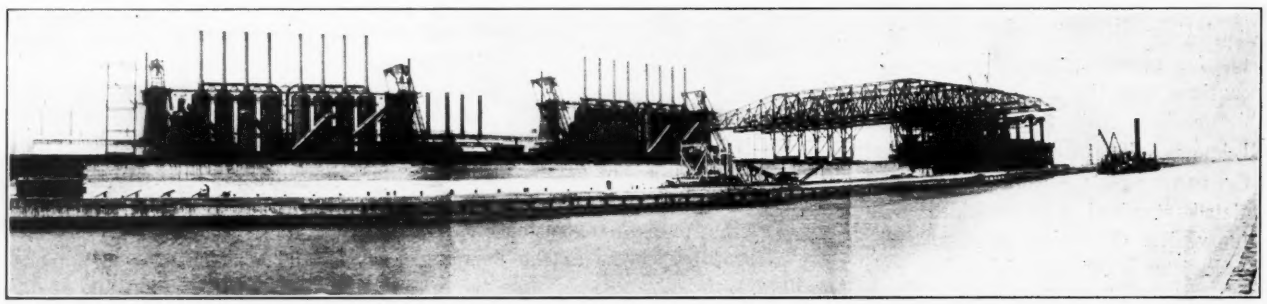
In connection with the generators the Allis-Chalmers Company has furnished Cutler-Hammer remote-control field rheostats and field switches. The controlling apparatus is located in the basement as near as possible to the generators and is operated from the bench board located in the power-house gallery. These rheostats are of a unique design, being what the manufacturers call the "cross-head" type. They are driven by means of vertical motors and are provided with automatic devices which insure the stopping of the motor at either limit of the "cross-head" travel, that is to say, either when all resistance has been cut in or out of circuit. Means are provided, also, for operating these field rheostats by hand in case of damage to the motor.

The power generated will be distributed throughout the works and used to operate the heavy induction-motor-driven rolls, the tilting and feed tables for the various passes, the hot saws, hot and cold pull-ups, hot rolls, transfer tables, straightening and drilling machines, cold saws, elevators, conveyers, pumps and a multitude of machines and mechanical devices auxiliary to the operation of such an enormous plant. Several of the motors built by the General Electric Company for these works are of 6,000 horse-power each, being designed for driving the rolls, and from this they range in size down to machines of the smallest capacity used to operate switches in the power-house.

The problems of control presented by the multitude of motors installed at this plant involve many interesting features, the solution of which was largely intrusted to the engineers of the Cutler-Hammer Manufacturing Company, of Milwaukee, and the automatic devices now installed at Gary represent the most recent developments in electric control as applied to steel-mill machinery.

The electrical system as a whole is subject to central control at a switchboard operated from a gallery sixteen feet high. This switchboard, which was designed by the Western Electric Company, has the usual complement of instruments of standard types, and a detailed description would involve more space than can be given to the subject here.

To aid in securing maximum economy under heavy fluctuations of load, by utilizing the full value of the generating power of the gas, without regard to the amount of current required at any given time for the operation of the mills, a storage-battery installation furnished by the Electric Storage Battery Company has been housed in a two-story building, eighty-seven feet long by forty-seven feet wide, located near the power station. The batteries will be kept charged as nearly as possible to their full capacity in order to assist in meeting, for a considerable period of time if need be, any demands for excessive power made upon the gas-engine-driven generators. These can, in themselves, be heavily overloaded, but the best power-factor is, of course, to be secured at about their rated capacity. The battery also aids in maintaining, at light loads, a constant pull on the generating equipment.



VIEW OF BLAST FURNACES FROM WATER-FRONT, INDIANA STEEL COMPANY'S PLANT, GARY, IND.

The subfoundation of the power station, as well as of each blower-house, is a solid mass of concrete underlying the entire structure on the level of Lake Michigan, and having a depth of five feet. Above this are separate foundations for each of the generating and blowing units.

The arches forming the roof of the power station have a clear span of eighty-five feet, providing headroom, at the dome, of seventy-three feet above floor level. The station is served by two fifty-ton cranes. Roofing is heavy galvanized corrugated steel. The interior walls for a distance of ten feet are of white enamel brick, but above that point the surfacing is in red pressed brick. The exterior consists of red building brick.

The plans of the plant provide for six batteries of basic open-hearth furnaces,

fourteen to the building, of which two batteries, or twenty-eight furnaces, are at present constructed.

With the four open-hearth buildings, now completed or under construction, in operation the Gary plant will have a capacity of over 12,000 tons of steel per day, or 2,000,000 tons per year. With all six buildings in use, the total capacity of the plant, as planned by the United States Steel Corporation, will be upward of 4,000,000 tons per year.

VIEW IN CENTRAL STATION, INDIANA STEEL COMPANY'S PLANT, GARY, IND., SHOWING GAS ENGINES AND GENERATORS IN COURSE OF ERECTION.

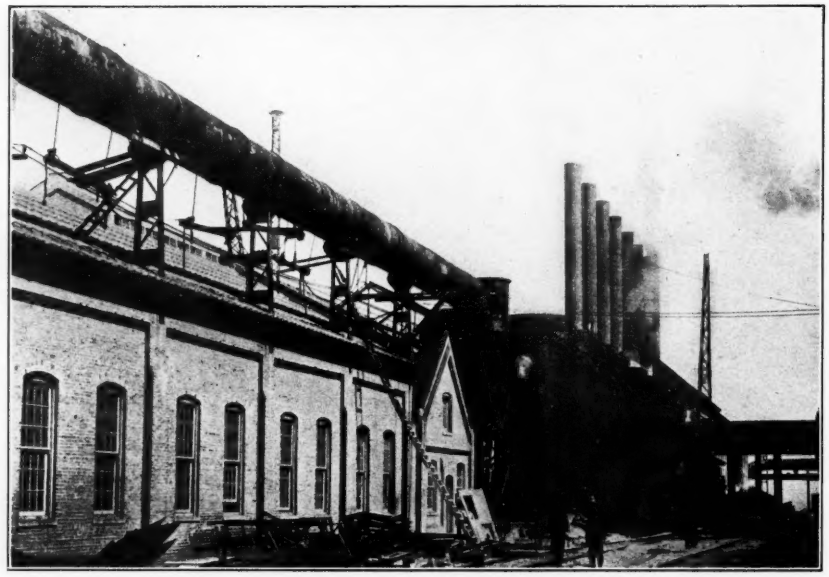
With everything running at top notch 4,000 tons of steel rails can be produced daily; and in normal operation the mill is expected to turn out 100,000 tons per month.

The group of rail-mill buildings, located about 300 yards from the lines of the open-hearth furnaces, constitutes in itself an enormous plant. The main structure is 1,800 feet long, and at right angles to it is another building of one-third the length, with a width in a single span of eighty-five feet. This contains twelve soaking pits or furnaces, each of which is supplied with gas from an independent Hughes mechanical gas producer. The arrangement here is such that ingots enter from the open-hearth furnace buildings along the entire length of one side of the pit building, the other side being reserved for the electrically operated ingot buggies which transfer the heated ingots through the first stand of rolls. Each of the twelve pits has four holes, six feet by six feet, and is provided with the usual equipment of hydraulic cylinder covers and reversing air and gas valves of the well-known Dyblie type. The ingots used are twenty inches by twenty-four inches and six feet long, weighing 8,500 pounds each. For the operation of the two ingot buggies used, Cutler-Hammer Manufacturing Company, of Milwaukee, has developed an ingenious system of control. On account of the length of the building in which the soaking pits are located, it is impossible for the operator stationed at the mill to see when an ingot buggy is opposite a particular pit. It was, moreover, deemed necessary to guard against the possibility of the operator becoming confused and bringing both ingot buggies to the mill at the same time, which would result in a collision. The special controlling system provides guards against this contingency, at the same time enabling the operator to automatically stop the ingot buggy at any of the pits. There are two master levers for the control of the two buggies. Each of these levers can be set in any of eight positions, one corresponding to the rail mill itself, six to the six soaking pits which each buggy serves, and one "off" position. If, when one of the ingot buggies is at the mill, the operator desires it to go to pit No. 5, let us say, and there stop, he merely moves the controlling lever to the position corresponding to pit No. 5, and the buggy proceeds to that point and is there automatically stopped. A suitable interlock between the two controlling levers is provided which renders it impossible for the operator to throw both

levers to the mill position at the same time, thus insuring a clear track for each buggy.

The rail mill is equipped with twelve sets or stands of roll trains, all operated at varying speeds by General Electric alternating-current motors, some of which are of the largest sizes ever constructed for industrial service. These are housed in a separate bay or "leanto" running parallel with the rolls. The rotors are twenty feet in diameter and have a speed of eighty-three revolutions per minute. All of the motors are connected directly to the roll trains by regular mill couplings. The aggregate driving capacity is 24,000 horse-power. Although the motors are provided with flywheels and operate in one direction, provision is made for reversing in case of necessity. The control system has been worked out with the greatest nicety, all operations being under the instant control of the operator by means of a master controller.

The first group of rolls consists of four stands of continuous forty-inch mills, each two of which are driven by a 2,000-horse-power motor. They are arranged in tandem, requiring no manipulation from stand to stand. Here, as elsewhere through the plant, sufficient distance is left between successive sets of rolls to enable a quarter turn of the ingot or bloom to be made, so that it is worked equally on all sides. The first two mills are at present equipped with forty-two-inch rolls, enabling twenty-inch by twenty-four-inch ingots to be used. After passing these four mills the ingot is sent to a forty-inch three-high blooming mill equipped with lifting tables and arranged with a combined hydraulic and pneumatic balancing device. This mill, which is operated by a 6,000-horse-power motor, gives the ingot five passes. After being bloomed the ingot is sheared in a ten-by-ten-inch horizontal blooming shear, and the crop ends or butts are taken outside of the mill by a butt conveyer of unusual construction, which was designed and built by the engineers of the Indiana Steel Company. Each bloom then goes through a twenty-eight-inch roughing mill, which is three-high and equipped with tilting tables. This mill has actually three stands of rolls. The roughing stand, however, is the only one that is three-high, the other two stands being two-high. The mill is driven by a 6,000-horse-power motor and gives the bloom three passes. After leaving the roughing mill the bloom goes through a two-high twenty-eight-inch forming mill driven by a 2,000-horse-power motor, receiving but one pass. Then it is sent to finishing mills, which consist of five stands of twenty-eight-inch mills driven by two 6,000-horse-power motors. After the dummy pass the bloom is transferred to the first edging, which is in this same mill but the second stand, and turns back on an elevated table to the second edging, which is in line with the twenty-eight-inch roughing mill. It then travels by chain transfer to the lower tables, and on the leading pass goes through a stand which is also in line with the roughing mill and driven by the same motor and continues on to the third stand of the twenty-eight-inch finishing mill, this being the eighteenth and last pass. After the finishing pass the rail travels through to the saws, of which there are five provided, thus cutting four rails to length. These four rail lengths consist of half the ingot. As the capacity of this mill is 4,000 gross tons per twenty-four hours it will be seen that there must be a four-rail length sawed about every half minute. The saws are forty-two-inch blades, arranged to be raised and lowered in unison by one controller from the hot-saw operator. After leaving the hot-saw run the rolls pass over the usual cambering machine and are run onto hot beds, 100 feet long, of which four are at present installed, with provision made for an additional two, if necessary. These hot beds extend to the south of the mill proper. In the finishing-mill section they are of unusual design, being made of structural material and placed eight feet above the floor, allowing for an extraordinarily large air space to facilitate the rapid cooling of the rails. The finishing building is 1,383 feet long, central with the hot beds, and provided with live rolls extending the entire length. The roller tables are equipped with stops and kick-offs to transfer the rails to the straightening presses, of which there are sixteen, built by the Hilles & Jones Company, of Wilmington, Del., these being of the usual type and motor-driven. From the straighteners the rails are transferred by the usual skids to three-spindle vertical drill presses furnished by William Sellers & Company, of Philadelphia, which are also motor-driven. These complete the rails for use. From the drill presses the rails are transferred to a roller table, which extends the full length of the building, and from which the rails may be skidded to the loading beds immediately outside of the building.



SECONDARY WASHERS OF GAS-CLEANSING SYSTEM, SHOWING BOILER HOUSE AT EXTREME RIGHT, INDIANA STEEL COMPANY'S PLANT, GARY, IND.

The principal machinery was built and installed by the United Engineering and Foundry Company, with the exception of the finishing department, which was erected by the Morgan Engineering Company. For the lifting tables and transfers Westinghouse motors are used.

In the rail mill a number of Cutler-Hammer automatic remote-control devices are installed, the most interesting of which are those designed for the control of the elevating and tilting tables, the bloom shear and the transfer. The elevating table on the forty-eight-inch blooming mill, weighing about 250,000 pounds, is supported on huge bell-cranks which are connected to a rotating crank driven by

a 250-horse-power motor operating at 150 revolutions per minute. By means of automatic controlling devices the throwing of a master lever starts the table from the low-level position and raises it to the highest level, where it is automatically stopped. In lifting the table from the low to the high level, the rotating crank moves through an arc of 180 degrees and, on throwing the master lever to the reverse position, the crank revolves another 180 degrees in the same direction, bringing the table to the low level once more. The operation of raising or lowering the table can be accomplished in a period of two seconds, which is quite remarkable when the masses to be accelerated, slowed down and stopped are considered. Its arrangement is similar to that of the elevating table, one end being pivoted and the other end supported on a bell crank. The tilting table is driven by a 150-horse-power motor controlled by a controller similar to that designed for the elevating table. The bloom shear is operated by means of a seventy-five-horse-power induction motor and the pin on the clutch by a direct-current auxiliary motor of five horse-power. The circuit of this motor is interlocked with the controlling device for the seventy-five-horse-power alternating-current motor so that the former can not be put in motion except when the latter is running at full speed. The latch is operated by a crank to which the five-horse-power motor is geared. Pressure on a push-button under control of the operator causes the motor to run long enough to revolve the crank 360 degrees, thereby releasing the clutch and returning the pin to the initial or "off" position.

Automatic controllers installed in connection with motors on the transfers make it possible for the operator to transfer the rail from one table to another by a simple throw of the lever, the motor being automatically stopped after the transfer has been completed.

For the operation of cranes, tables and other apparatus, in and about the rail mill requiring direct current, two 500-kilowatt synchronous motors driving direct-current generators have been furnished by the General Electric Company. This equipment, with the necessary switchboards, is located in one of the motor houses at the rail mill and designated "Substation No. 1." Other substations suitably equipped are being located in other sections of the plant.

The billet mill consists of four continuous stands of forty-inch blooming mills, each two of which are driven by a 2,000-horse-power motor. After leaving these the ingot is turned end for end on a turntable and passes through a five-stand thirty-two-inch continuous mill, the entire mechanism of which is driven by one 6,000-horse-power motor. At the end of this mill is placed a twelve-inch by twelve-inch horizontal blooming shear and also a ten-inch by ten-inch vertical blooming shear, from either of which shears either sale blooms or blooms for the twenty-four-inch mill immediately following may be sheared. The sale blooms are run out on hot beds on the other side of the building where there is a loading yard equipped with overhead traveling cranes. Blooms intended to be further reduced after being sheared are sent through the twenty-four-inch continuous mill, which consists of six stands driven by a 6,000-horse-power motor, reducing the blooms to four or five inches square. At the end of the twenty-four-inch mill is placed a roller table. The billets may be transferred to an eighteen-inch continuous mill to be further reduced or, if for sale, to a shear and from thence to overhead billet pockets from which they may be loaded directly into cars.

For the further reduction of billets taken from the above-mentioned transfer skids the billets are run through an eighteen-inch six-stand continuous mill, driven by a 6,000-horse-power motor and equipped with flying shears.

All of the machinery is electrically driven, General Electric, Crocker-Wheeler and Westinghouse motors being used. This machinery was also furnished by the United Engineering and Foundry Company.

The additional mills to be built are a sixty-inch universal plate mill, which will be the largest of its kind in the world, and a forty-four-inch by 160-inch sheared-plate mill. These two mills will each be served by a thirty-two-inch slabbing mill. Further extensions to the Gary works include an axle mill, structural mill and eighteen-inch, fourteen-inch, ten-inch and eight-inch merchant mills.

The plant for handling ore from the vessels consists of Hulett unloaders and Hoover & Mason bridges of sufficient capacity to furnish material for the eight blast furnaces already built, each of which will deliver 500 tons of pig-iron daily, and for the eight additional furnaces yet to be constructed.

The ore bins and auxiliary apparatus were constructed by the Brown Hoisting Machinery Company, of Cleveland, Ohio, except the electric hoists operating the skids to the blast furnace tops, which are of the Otis Elevator Company's standard design for this service.

In connection with the furnaces and mills of the steel plant proper there have been erected a group of buildings of general utility, consisting of a machine shop, foundry, boiler shop, blacksmith shop, pattern and carpenter shop, pattern storage building, roll shop, electrical repair shop, brick storage house and a very well-equipped general store house. There has also been provided a yard-locomotive house, which is rectangular in shape, with tracks running through on an angle from one side to another, thus avoiding the use of a turn-table.

With all of the power economies which the plant of the Indiana Steel Company possesses, ridding it of gas and smoke, Gary will be one of the few examples of a clean city located near iron and steel works, and every effort is being exerted to make it a model town of its class. The steel company, through its real estate department, the Gary Land Company, has already built about 500 houses of various types and sizes. At present Gary has about 8,000 residents, and it is an incorporated city.

In addition to seven steam roads, most of which are trunk lines, there is a street and interurban electric railway running east and west and north and south through the town, connecting it with the various manufacturing centres located along the southern shore of Lake Michigan, as well as with lines running directly into Chicago.

In practically all respects Gary will be quite different from other communities built under somewhat similar conditions. There will, as a recent writer has said, "be a marked absence of the hovels, dirt and squalor so pronounced a feature of most manufacturing cities." It is to be a clean city, free from smoke and soot, principally because a great corporation has learned how to conserve the appalling misuse of fuel from which these evils spring; and, with the magnificent start which has been given the community, both civic and individual pride will undoubtedly keep municipal affairs upon a higher plane than is common to large industrial centres. Gary stands for a long step ahead in the great economic movement toward elimination of waste, whether material, mental or moral; and its welfare is of genuine concern, not only to the Indiana Steel Company and to its inhabitants, but also to the nation at large. The officers of the Indiana Steel Company are: E. J. Buffington, president; G. C. Thorp, vice-president; T. J. Hyman, secretary and treasurer; K. K. Knapp, general counsel.

REVIEWS OF CURRENT ENGINEERING AND SCIENTIFIC LITERATURE

Influence of Electricity on the Growth of Plants.

Among the manifold methods for advancing the growth of plants by electricity that of Lemstroem is again attracting particular attention. The investigations of Professor Lemstroem, of the University of Helsingfors, who died two years ago, have extended over more than a lifetime. His observations of plant growth in northern regions, which is striking on account of its unusual rapidity and luxuriance, led him to the conclusion that special causes must be at work here, which partly substitute warmth, the principal factor in plant growth. He found the cause in the stronger atmospheric discharges in northern regions, of which the aurora borealis is a notable example. After some successful experiments with plants in pots, Lemstroem erected a net of wires over larger surfaces of land, which in most cases he charged positively by means of a static machine, while the negative pole was connected to the ground, and permitted a dark discharge to influence such an experimental field during the entire period of vegetation, while a control field nearby remained uninfluenced. The experiments were carried on in different latitudes, and with correct treatment always resulted either in an increase of the crop varying between eighty and 100 per cent, or a shortening of the period of ripening, or else in a marked improvement of the quality. The largest surface experimented upon by Lemstroem was 3.5 hectares (about eight acres). A remarkably small quantity of electrical energy was necessary, a one-tenth-horse-power motor being sufficient to drive the static machine. Lemstroem considered electroculture ready to play an important part in agriculture and horticulture on a large scale, for improving the quantity and quality of crops, but there were still a number of practical considerations in the way of putting the method into practice. One was the imperfect way of producing static electricity by the unreliable and inefficient static machine; another the inconvenience caused by the presence of the wire net during the cultivation of the soil. It was necessary for the technical man to perfect this part of the process. This was done three years ago by Mr. Newman, in England, who tested the method practically on a much larger scale. He succeeded in interesting Sir Oliver Lodge, who proposed the use of special mercury rectifiers patented by him for obtaining the necessary high-tension direct current from alternating current transformed to a high pressure. The tension used is 100,000 volts, but is entirely harmless on account of the extraordinarily small amperage of the current. According to a recent report of Sir Oliver Lodge the experiments have been extended during the years 1906 to 1908 to a surface of ten hectares (about twenty-five acres), and it was demonstrated that with the high tensions employed the wire net may be at a height of five metres above the ground without destroying the beneficial effect. This height will not interfere with any agricultural labors; Lemstroem was obliged to prescribe a height of not more than forty centimetres because of the ineffective apparatus employed by him. Improvements have also been made in the construction of the wire net without apparently decreasing the effect, so that the entire method now seems to be ready to be successfully put into practice.—*Translated and abstracted from Elektrotechnische Zeitschrift (Berlin), September 17.*

New Facts About the Quartz Lamp.

Some peculiarities of these lamps, which have been extensively adopted since their introduction in the fall of 1907, are pointed out by Oskar Bussmann. The quartz lamp is a mercury vapor lamp made of pure fused quartz. As this material can withstand extraordinarily high heat without softening, the mercury vapor arc can be brought to much higher temperatures than in glass tubes. It has been shown that the economy of the mercury arc in glass tubes increases with the rise of temperature up to a certain degree and then diminishes again; but when the fused quartz is substituted for glass and the temperature raised still higher than is practicable in glass tubes, it is found that a great increase in economy takes place before the quartz begins to soften and far exceeds that of common arc lamps. Quartz also has the advantage of being absolutely insensitive to temperature changes, as its expansion coefficient is almost equal to zero, and therefore red-hot quartz can be plunged into cold water without cracking. This property contributes greatly to the strength and life of the lamp. The burner consists of a quartz tube six centimetres to twelve centimetres long and one centimetre to one and one-half centimetres in diameter. It is arranged in a nearly horizontal position. Two small tubes are fused across the ends and contain the mercury into which the terminals are led. The real source of light is the arc passing between the mercury poles through the tube. The arc is started by bringing the mercury electrodes in contact with each other and then separating them. This is done automatically by an electromagnet which tilts the lamp when it is switched on. The quartz tube must be highly evacuated, as otherwise it is difficult to produce an arc. When the arc is started mercury is vaporized at the poles in large quantities and the vapor pressure increases according to the load. In glass tubes the pressure rises to two millimetres to three millimetres under normal conditions, but the quartz burner is strained to 760 millimetres mercury column (one atmosphere) which equals the atmospheric pressure outside, and so there is no strain on the burner during operation. The economy of the quartz lamp is the higher the greater the pressure inside of it. But it is undesirable to use pressures above one atmosphere as the quartz might crack. In glass tubes the bluish mercury vapor arc fills the entire interior uniformly. Its temperature is only 300 degrees to 400 degrees centigrade. When a quartz lamp is started the arc also fills the entire tube, but after a few minutes, as the vapor pressure rises, it recedes from the walls and contracts toward the middle of the tube, until finally it forms a band in the centre about five millimetres in diameter. At the same time the violet-blue tint of the light changes to a yellowish green and its intensity increases enormously. During the starting period the lamp absorbs only twenty-five to thirty volts, but when the pressure has increased to one atmosphere the tension is about 180 volts. The time necessary for attaining the definite vapor pressure and full light intensity naturally depends on the amount of energy supplied to the

lamp. If 3.5-ampere lamps were supplied from the beginning with 3.5 amperes, they would absorb only 3.5 × 25 = about ninety watts, which is not sufficient to bring the mercury to boiling temperature; therefore the initial current intensity must be as high as the operating conditions will permit, which may be considered to be ten amperes for 3.5-ampere lamps. This requires a resistance of at least nineteen ohms on 220-volt circuits. The gradual regulation of the resistance is effected automatically by employing resistances of iron wire. Iron has a high temperature coefficient and its resistance quadruples when it is brought to a light-red heat. The dimensions of the wire are so chosen that the high initial current intensity of the lamp will bring it to a light-red heat, and it therefore takes up about 130 volts, but at the definite current intensity of 3.5 amperes it is only slightly heated and absorbs no more than fourteen volts. The quartz lamp is furthermore provided with an adjustable resistance in order to adapt it to the different pressures in use, 220 to 240 volts.

The metallic conductors through the quartz walls of the mercury vessels must have the same coefficient of expansion as quartz and must not be attacked or dissolved by the mercury; and the only material suitable for this purpose was found to be the nickel steel discovered by Guillaume, of Paris. The right temperature of the pole vessels is essential to the proper working of the lamp, as it determines the vapor pressure in the lamp and the intensity of the current flowing through it. In order to adjust the cooling of the pole vessels according to the conditions under which the lamp is used —exterior or interior lighting—they are surrounded by peculiar coolers of copper sheet, whose radiation surface may be varied. Quartz lamps should be used without a globe only when their ultra-violet rays are to be utilized, and in such cases employés near them should protect themselves from these rays which produce skin inflammation. If light of better color is desired, it can only be obtained by using incandescent lamps in connection therewith. The fact that the Koerting & Mathiesen Actien Gesellschaft, the Illgemeine Electrizitäts Gesellschaft and the Siemens-Schuckert Works have united in introducing these lamps would seem to indicate that they are considered of importance. — *Translated and abstracted from Elektrotechnischer Anzeiger (Berlin), September 10 and 17.*

MEASUREMENTS WITH PORTABLE INSTRUMENTS.[1]

BY F. P. COX.

Inaccuracies in reported values may be divided into two classes—those due to errors of the observer and those due to the errors of the instrument. Under the former must be included errors due to incorrect connections, which are by no means unusual in the measurement of polyphase circuits, errors due to not noting and allowing for zero errors in the instrument and errors due to parallax which may be avoided by properly using the image of the needle reflected from the mirror under the scale.

The personal equation of an observer which causes one man to read the needle as above and another as below the true position, need not be taken into account in commercial measurements. When a needle is fluctuating through a considerable angle, it is sometimes difficult to estimate its true position. If the most dead-beat instruments available are used, no further precautions are possible, except to take the average of a considerable number of readings. These readings should be jotted down as fast as they can be taken and no attempt made to obtain the average reading by estimating with the eye the mean position of the needle. Even with this precaution, great reliance must not be placed on observations taken under unfavorable conditions. The results, at best, are approximate.

A fruitful source of error is the habit of reading instruments when the deflection is small. The average observer, using a reasonable amount of care, can not be relied upon to estimate the position of a needle much closer than one one-hundredth of an inch, and at one-fifth scale the error introduced is five times the magnitude of a corresponding error at full scale. It is recommended that deflections of less than twenty per cent of the full scale be classed as approximate. All instruments have errors due to temperature changes and are affected by local magnetic fields. The errors so introduced may be a very small fraction of a per cent or they may amount to several per cent, depending upon the design and type of instrument. Local field errors may be noted and, if not too great, allowed for, by reversing the leads to the instrument or by turning it through 180 degrees. The mean value of the observations should be taken as the correct reading. It must be remembered that local fields are found, not only in the immediate vicinity of buses carrying large currents, but also some distance away where they have been carried by the iron framework of the switchboard or of the building. Sometimes an unshielded instrument is read when resting on the iron grating of a switchboard gallery or on a hand rail, and errors of considerable magnitude may result. Such errors can not be corrected by reversing the position of the instrument or by reversing leads, since they are due to the presence of a mass of iron in the vicinity of the instrument.

Scale errors, due to incorrect marking, are generally small, not amounting to over two-tenths of a per cent, and are most liable to be found in the subdivisions of the scale, since each subdivision is not an observed point. It is customary to observe and check the principal divisions, in some cases the half divisions, and to interpolate the intermediate ones.

Care of instruments or, rather, want of care, should be considered as a very important source of error. Shelves provided with a thick felt covering should be used for storing them. Such shelves are inexpensive and pay for themselves in reduced repair bills and improved accuracy. The instruments should be in charge of one competent man who will examine their condition when they are returned to his stock. He should see that they are compared with suitable standards once or twice a month and frequently cross-checked. He will soon determine which employés are treating the instruments properly and which are abusing them. Such abuse may consist in careless handling in use or in transportation. In riding in street cars the careful instrument man will keep his instruments in his lap or on the cushioned seat. The careless man will drop them on the floor. In sending instruments out by wagon felt-lined boxes should be provided to protect them in transit. It is well to purchase instruments of high torque and robust constitution, but it should be remembered that the term "robust" is only comparative. Instruments should be given the same care which is given to a valuable watch, and no matter how strong the instrument may be, it will not be improved by rough handling.

The measurements which are most commonly made by lighting or power companies are of potential, current, energy and time. Perhaps the latter might seem rather beyond the scope of this paper, but it is an important factor in the calibration

[1] A paper read at the twenty-fourth annual meeting of the Association of Edison Illuminating Companies, held at Lenox, Mass., September 15, 16 and 17, 1908.

of meters and it seems advisable to make some mention of probable errors in this measurement.

POTENTIAL.

In considering the subject of errors in measurement of potential, it is necessary to divide this subject into two types of circuits, continuous and alternating currents. It is well recognized that the best type of instrument for measuring continuous-current circuits is the D'Arsonval. For economy of energy absorbed and deadbeat qualities, this instrument is a most satisfactory one. The best instruments of this type have a resistance of about 100 ohms per volt of scale reading. The errors introduced by temperature changes are insignificant, except in those multiple-scale instruments which have a tap for one and one-half or two volts full-scale reading. Where this tap is used the accuracy of the low-reading scale should be regarded with suspicion, since it is liable to have a temperature error of about one-tenth of one per cent per degree centigrade. This type of instrument, when provided with a iron case, is practically shielded from all ordinary magnetic fields. Normal earth's field introduces an error of about one-tenth of one per cent in unshielded instruments and such instruments should not be used nearer together than eighteen inches. If placed side by side these instruments react on each other and an error of one per cent may very readily be introduced.

The generally accepted model of voltmeter for measuring alternating potential is of the dynamometer type. Those designed for 110-volt circuits have a resistance of from 1,500 to 2,000 ohms or about twelve to fifteen ohms per volt. The resistance of the instrument is somewhat affected by temperature on account of the percentage of copper which it contains, but this is almost exactly compensated for by a corresponding temperature effect on the spring. Double-scale instruments of this type should be limited to a ratio of 2 to 1 between scales, or with special designs, 4 to 1. When designed for the higher scale, bringing out a tap for less than half scale introduces more copper in the circuit than the spring will compensate for, and frequency errors must be expected on account of the change of the instruments' time constant. In building double-scale instruments with a ratio of 4 to 1 between scales, it is customary to design them so that frequency and temperature errors are negligible on the lower scale. The result is an instrument which takes a large current, and the key must not be permanently depressed on the high voltage. Even special design will not permit self-contained instruments to be made with a ratio of more than 4 to 1 between scales, and greater ratios should be obtained by means of external multipliers. These dynamometer instruments should be protected by means of a suitable shield from any ordinary magnetic field, since, unshielded, they have an error of about one per cent, due to normal earth's field.

Although designed primarily for alternating currents, when there is no very marked difference between reversed readings they may be used on continuous-current circuits by considering the correct reading as the mean of the reversed observations. When used with potential transformers the errors of the transformers must be added to the normal instrument error. Account must be taken of the regulation of the transformer, as affected by the connected load and also by the frequency of the circuit on which it is used. A regulation of from one and one-half to two per cent between voltmeter load and full load is not improbable. The correction factors for the transformers can be supplied by the builders and should be taken into account where best accuracy is desired.

CURRENT.

The D'Arsonval ammeter for measurements on continuous-current circuits differs from the voltmeter only in regard to errors due to temperature. In this respect, however, it differs materially and is often credited with an accuracy which it does not possess. Temperature changes affect the accuracy of the instrument in three different ways.

First, in those types of instrument where an attempt is made to avoid errors on account of change in room temperature, it is necessary that the shunt should have the same temperature coefficient as the instrument itself; and, since this coefficient is not low, five or ten minutes after such instruments have been connected, errors of two or three per cent, or even more, may be noted. These errors are due to the fact that the shunt is absorbing energy and increasing in temperature more rapidly than the measuring circuit.

Second, where an attempt is made to avoid the error by making the shunt of zero temperature coefficient material, an error, due to change of room temperature, is introduced. Since the temperature coefficient of the measuring circuit is practically half that of copper, an error of one-tenth or two-tenths of a per cent is caused by each degree centigrade, which the room temperature changes. This error may, however, be reduced to a negligible quantity by using shunts which have a drop of 200 millivolts in place of the forty or sixty millivolts used in switchboard shunts. The extra size and weight are well warranted on account of the improved accuracy obtained.

The third error is found in those shunts which have zero coefficient materials and is due to thermoelectric currents set up in the measuring circuit. These currents are caused by difference in temperature of the shunt terminals. Such differences in temperature may be due to improper contact with the bus, to a difference in circulation of air at the two ends, or more usually, it is due to the Peltier effect. Such thermoelectric currents may be avoided by using materials which have practically no thermoelectric difference of potential between the metals of the terminal and the shunt strip, or by adding a thermoelectric compensator which sets up a thermoelectric effect of equal magnitude and opposite sign.

Ammeters for the measurements of alternating currents are usually of the iron-vane type. The only error which is characteristic of this type of instrument is that due to variation in wave form and this error is within one-half per cent. When used with current transformers, errors of considerable magnitude may be introduced. These errors increase as the impedance of the secondary circuit of the transformer increases and as the primary current diminishes. Where a five-ampere instrument is used as the only load on the secondary circuit of the transformer, above one-fifth scale inaccuracies greater than one-half per cent are not liable to be found. It is not permissible to substitute a two-ampere instrument for lower readings unless the corresponding curve of the transformer under the new condition is at hand, for the inductance of the two-ampere instrument is more than six times that of the five-ampere and this additional load on the secondary introduces considerable error. Where transformers, in addition to the portable ammeter, carry a load of one or two stationary instruments and a tripcoil, an error of three per cent to five per cent at one-tenth load is by no means improbable and an error of one-half per cent at full load is to be expected.

ENERGY.

Portable indicating wattmeters for the measurement of energy are of the dynamometer type and on continuous-current circuits, or non-inductive alternating cir-

cuits, their characteristics do not materially differ from those of the dynamometer type of voltmeter. But when used on highly inductive circuits, or with transformers, additional errors are introduced. Errors due to mutual induction of the two circuits are small and may be neglected in commercial measurements. Errors of self-induction may not be neglected in measuring highly inductive circuits such as core losses of some transformers. The best instruments have an inductance of potential circuit of about one one-hundredth henry and at sixty cycles a displacement of potential current of approximately five minutes. Consequently, when used in connection with inductive circuits of power-factor one-tenth, the instruments indicate one and one-half per cent higher than the true watts and at one-quarter power-factor, half of one per cent. Instrument connections should be so made that the loss of the potential circuit, rather than that of the current circuit, is included in the reading, and this loss should not be deducted until after the correction factor mentioned above has been applied. Although this error on low power-factor tends to cause the instrument to read too high on lagging load, yet it is not unusual to find an instrument reading low on low power-factor and the magnitude of such error is sometimes greater than that due to self-induction of the potential circuit. This error is usually due to eddy currents in the metal parts of the instrument. It varies with the frequency, current and power-factor of the circuit and with the position of the moving coil at the time the measurement is made. No correction factor can be given, but with proper design the disturbance may be reduced to a negligible quantity. In these low power-factor measurements, care must be used not to overload the current coil of the wattmeter, for its capacity is often very much exceeded before the instrument is at one-half scale deflection. A short-circuiting switch across the current coil is recommended.

When used with either current or potential transformers, or with both, the errors mentioned in connection with voltmeters and ammeters must be allowed for, and, in addition, the phase displacement between the primary and secondary circuits of the transformers must be taken into account. The magnitude of this displacement depends principally upon the design of the transformers and the time-constant of the devices in the secondary circuits. In well-designed potential transformers, this phase displacement will not amount to more than five of six minutes at light secondary load, and the secondary potential leads the primary. As the full secondary load is approached, if the load is non-inductive, such as potential circuits of indicating instruments, the displacement may become ten minutes lagging, while if the load is mostly inductive, as for example, the potential circuits of induction meters, it may become thirty to thirty-five minutes leading. If the current being measured is non-inductive, no appreciable error is introduced by this change, but with power-factor one-half and a fully loaded potential transformer, the instrument may read one-half per cent high or one and one-half per cent low, depending on whether such load is principally non-inductive or highly inductive. With lightly loaded potential transformers this error would not amount to more than one-half per cent.

In current transformers this displacement of phase between primary and secondary current is usually greater than in the potential transformers. With one or two instruments on the secondary and full current in the primary, it may amount to thirty or forty minutes, and the secondary current leads the primary. As the primary current decreases, this angle increases. At one-quarter load it is about one degree and at one-tenth load, about one and one-half degrees. This means an error on a non-inductive load of one one-hundredth per cent at full load, one-fiftieth per cent at one-quarter load, and one-thirtieth per cent at one-tenth load, the instrument reads low. At power-factor one-half these errors become one and one-half per cent at full load, three per cent at one-quarter load and four and one-half per cent at one-tenth load, and the instrument reads high on inductive load. It is therefore evident that combinations of transformer and instrument errors may not infrequently occur in which the error of the wattmeter reading may exceed five per cent at power-factor as high as one-half and that an accuracy better than three per cent is not to be relied upon without taking all possible precaution and having at hand the correction factor for each individual piece of apparatus used. With such correction factors applied, errors greater than one to one and one-half per cent need not be expected.

TIME.

The accuracy of stop watches is generally very much overestimated. Watches with compensated balances and well-jeweled bearings are purchased. It is a poor watch which can not be adjusted to keep time with an error not greater than one minute per week. That is, as a timepiece, its error is within one hundredth part of one per cent. The balance wheel of a watch completes its excursion of approximately 250 degrees in one-fifth of a second. It is necessary for good time-keeping qualities that its motion should be free as possible and that it should be entirely disconnected from the train for the greatest possible portion of this excursion. It swings entirely free for approximately 240 degrees, during which time the train drives the hand forward one-fifth of a second division and again locks it from any movement during the 240 degrees of the balance wheel excursion. In other words, the hands of a watch are absolutely stationary during ninety-five per cent of any interval of time and it makes no difference in the movement of the stop hand, whether it is thrown in mesh at the beginning or the end of an excursion of the balance. Therefore, with a perfect timepiece, a perfect stop mechanism and absolutely no error on the part of the observer, an error of practically one beat or one-fifth second may easily occur in measuring time. In thirty-second observations, this error may amount to two-thirds per cent. When we add to this error those due to imperfect stop mechanisms, a throw of the hand in the interval between freeing it from the friction clamp and meshing it with the train, a similar throw in disconnecting from mesh and again clamping it, and the inaccuracy of the meshing itself, it is not difficult to realize that an additional error of one-half per cent may be introduced. The only precautions which can be taken are to use two stop watches, one in each hand, to practice operating the stop mechanism with as little jar as possible to the watch, to reject any observation in which the watches do not agree within two-fifths second, and to refuse absolutely any measurement covering a period of less than fifty or sixty seconds.

In conclusion permit me to express the hope that nothing in this paper may be considered as a reflection on reasonable accuracy of portable measuring instruments. I have sought only to show that laboratory accuracy may not be obtained under other than laboratory conditions, that errors of one or two per cent represent reasonable commercial accuracy and that even this may not be relied upon unless the best judgment is exercised in the selection, care and use of portable instruments. Purchase those instruments which are best adapted to the conditions under which they are to be used, place them in the custody of an experienced instrument man and give him facilities and authority in control of them which will insure their proper use.

INDUSTRIAL SECTION

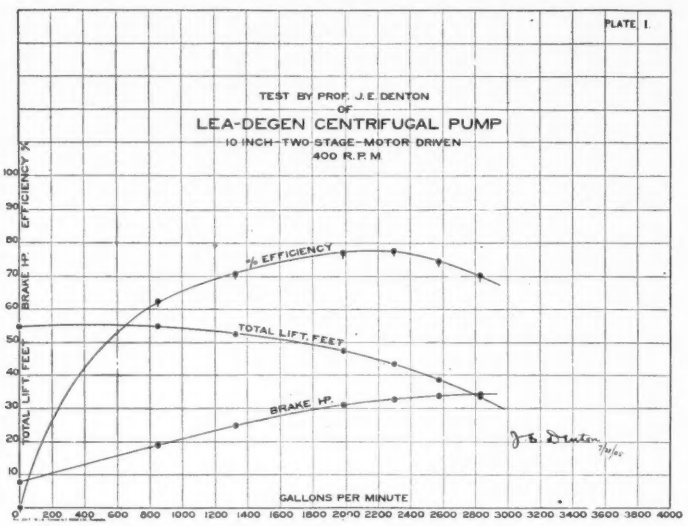
ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS

The Lea-Degen High-Duty Turbine Pump.

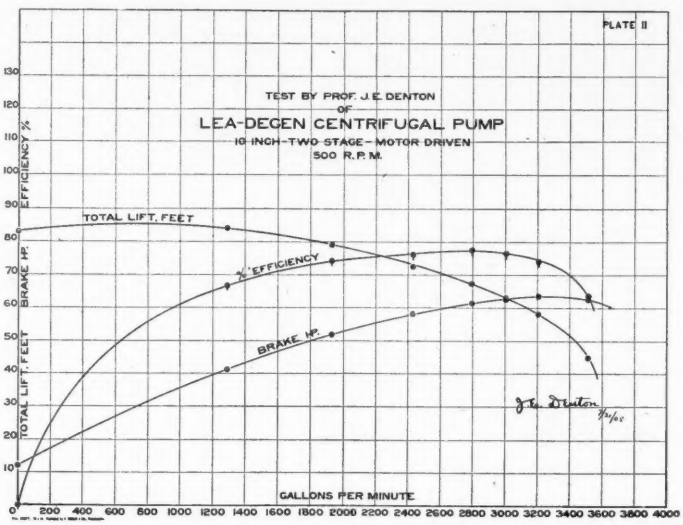
The Lea Equipment Company, 136 Liberty street, New York city, has placed on the market a motor-driven high-duty turbine pump, illustrations of which are shown herewith. The complete line of pumps is made of separate units that are designed for heads from seven to 1,000 feet or higher, and their capacities range from seventy-five gallons to 30,000 gallons per minute. The general design of the pump is indicated in the illustrations. It consists essentially of two shrouded runners or pump wheels mounted on the same shaft in a double case. The case is so proportioned that the water is drawn from the source of supply and put under pressure by the first wheel and then delivered to the suction chamber of the second wheel. The second wheel imparts to the water the same amount of energy it receives from the first wheel, thereby increasing the pressure, and then delivers the water into a spiral discharge conduit terminating in a diverging nozzle connecting with the main pipe.

The case is divided through its horizontal diameter by bolted flanges, so that its top half can be quickly freed and lifted off without disturbing either suction or discharge connections. By means of bolted circumferential divisions of the case provision is made for either using the suction and discharge end of a case together as a single-stage pump or adding as many intermediate sections as may be necessary to afford any desired pressure at any fixed speed. Additional stages can therefore be installed after a pump has been in operation, without wasting any parts of the existing case.

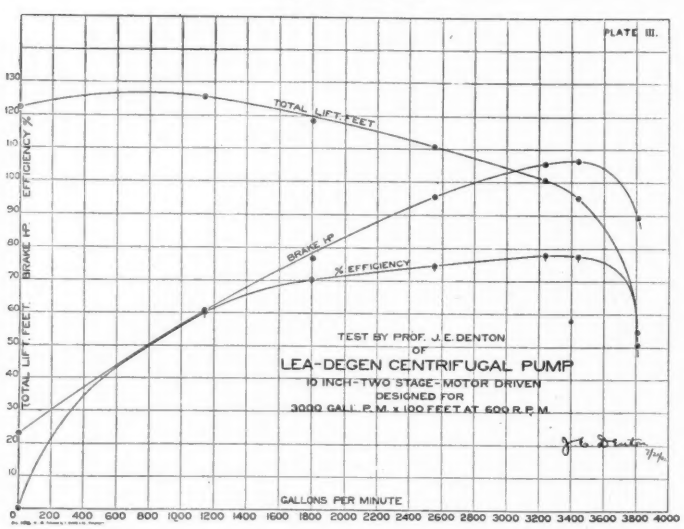
The curves herewith show the results secured under a test conducted by Professor James E. Denton, of the Stevens



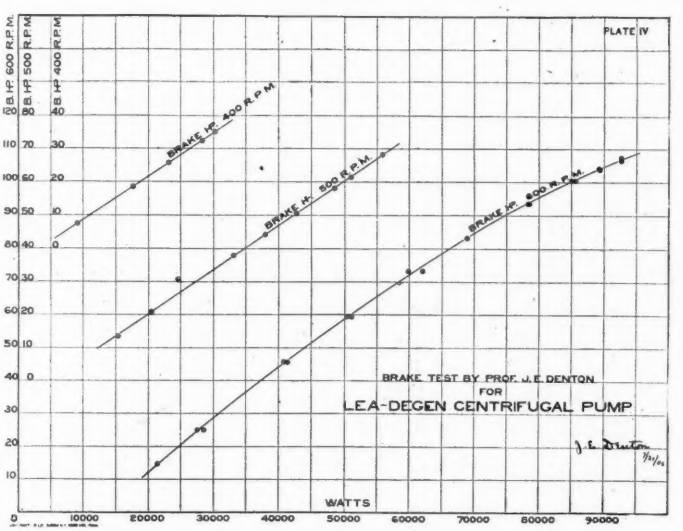
"Gallons-Lift" Curve for 400 Revolutions Per Minute Turbine Pump.



"Gallons-Lift" Curve for 500 Revolutions Per Minute Turbine Pump.

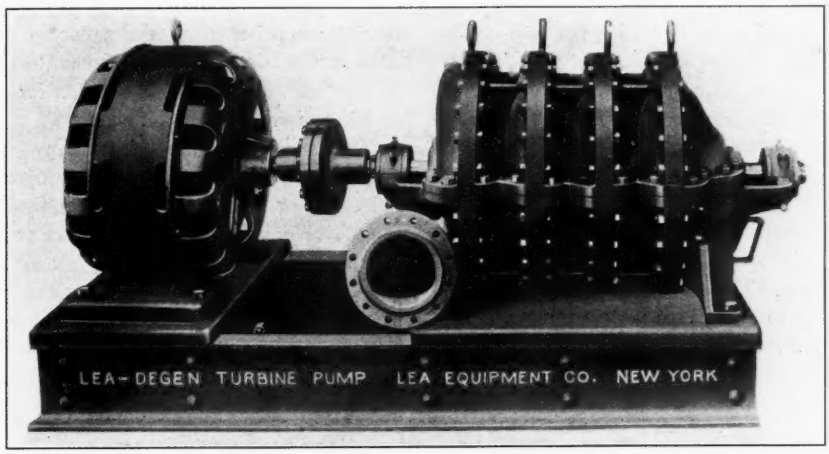


"Gallons-Lift" Curve for 600 Revolutions Per Minute Turbine Pump.



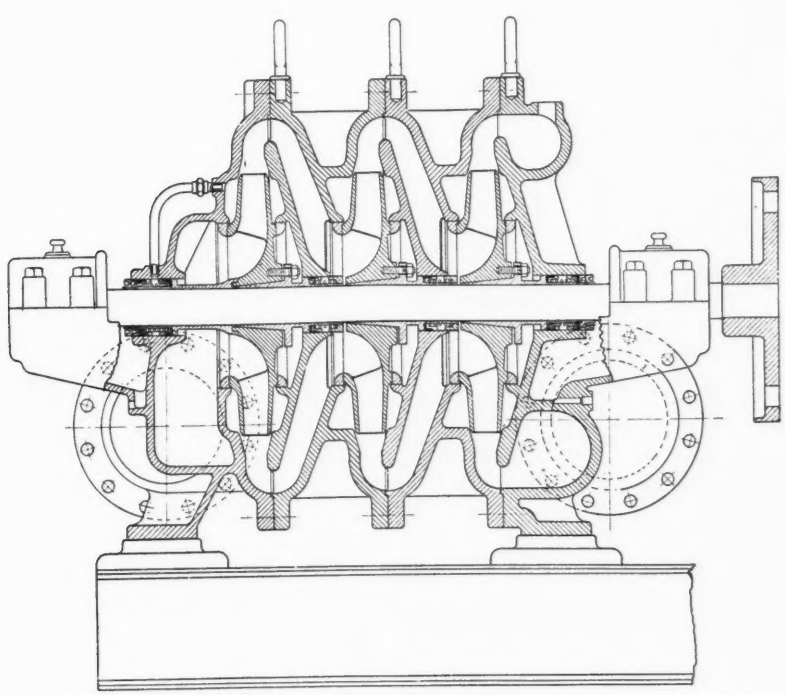
"Brake-Horse-Power-Watts" Curve, Turbine Pump.

Institute of Technology. This test was conducted on a Lea-Degen two-stage centrifugal pump driven by a 220-volt, direct-current General Electric motor. The test



THE LEA-DEGEN MOTOR-DRIVEN TURBINE PUMP.

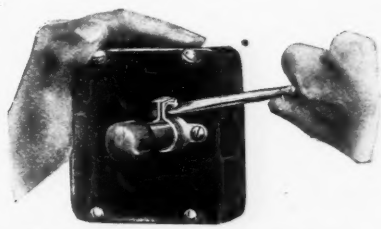
shows that the pump gave the following results, under conditions of maximum efficiency: At 400 revolutions, seventy-seven per cent efficiency with a capacity of 2,296 gallons under 43.6 feet lift; at 500 revolutions, 77.6 per cent efficiency with a capacity of 2,794 gallons under 67.4 feet lift; at 600 revolutions, 77.97 per cent efficiency with a capacity of 3,235 gallons under 100.7 feet lift. In round numbers, therefore, the capacity at maximum efficiency is directly proportional to the revolutions, and the lift, or head, is proportional to the square of the revolutions. At each speed the efficiency averaged more than seventy-six per cent over a range of 600 gallons of capacity for the two lower speeds, and 900 gallons at the highest speed, the head remaining nearly constant.



SECTIONAL VIEW OF TWO-STAGE LEA-DEGEN PUMP.

A Clamp for Ceiling Outlet Boxes.

A neat little device for fastening ceiling outlet boxes to the dummy or gas pipe has recently been put on the market which bids fair to eliminate many of the difficulties experienced in installing boxes in the old way.



CLAMP FOR CEILING OUTLET BOXES.

The outlet box is held firmly in position at right angles to the pipe, so that there is no chance of breaking the plaster by swaying fixtures. The opening where the pipe passes through the box is also filled up, thus preventing flames from being drawn up through it in case of fire being started by a short-circuit or loose contact.

The clamp is made in two sizes, three-eighths-inch and one-half-inch, with two lugs for ordinary purposes, and three lugs for heavier work, such as in fire-proof buildings.

It is manufactured by the Federal Electric Company, of Chicago, and is approved by the Underwriters' Laboratories.

The Lang "Quixet" Floor Box.

The accompanying illustration shows the Lang "Quixet" floor box, made by the J. Lang Electric Company, 116 Lincoln

THE LANG "QUIXET" FLOOR BOX.

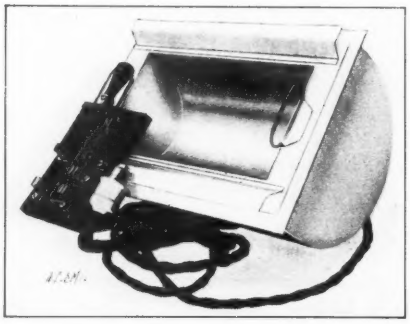
street, Chicago, Ill. This box is designed to overcome all of those disadvantages with floor boxes which have proven expensive and annoying in their use. In installing this box it is not necessary to cut out or adjust the floor in any way. The box adjusts itself to the floor without the use of screws, gaskets or other devices. It is smaller than the ordinary floor box, and will fit into installations where the ordinary box would not be permissible.

Electrically Heated Chocolate Warmer.

Among the industrial applications which are being successfully met with electrically heated devices, the confectioner's chocolate warmer or dipping pan is an example. The Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa., is making the Hadaway electrically heated dipping pan, an illustration of which is shown herewith; and which is being used by a large number of prominent candy manufacturers in this country and abroad.

The pan consumes about the same amount of current as a sixteen-candle-power lamp. The heater is placed in operation by closing a switch. A further advantage of the Hadaway electrically heated chocolate warmer for refrigerated rooms arises from the fact that the dry, flameless heat results in a great reduction in the expense for cooling.

Hadaway electrically heated chocolate warmers are usually made with a high and low heat, the change from one to



Electrically Heated Chocolate Warmer.

the other being made by a small switch. The low heat is sufficient to maintain the chocolate at the proper working consistency, while the high heat is designed to bring the chocolate to the working temperature in a short time. When desired, warmers can be supplied having only the low heat. These are used in connection with chocolate melters, but it occasionally happens that the chocolate cools in the pan, causing loss of time and delay in the work. This can be avoided by using the two-heat apparatus with which the high heat will be available whenever required.

The warmer is made in two standard sizes. The large size is fourteen and one-quarter inches long, seven and five-eighths inches wide and six inches deep. The small size is twelve inches long, six and one-quarter inches wide and five inches deep. These dimensions refer to the pan in which the chocolate is placed. The heating element is upon the outside of a receptacle in which the chocolate pan is placed and is hermetically sealed in by an outer jacket. The heater and wires are shielded so that accidental contact with them can not be made and the operators are absolutely protected from all danger of an electric shock.

The warmers can be set in the top of a table and connected with the heat-control switch by the engineer on the premises according to a simple wiring diagram sent out with the apparatus. The chocolate warmer can be connected to a lamp socket, but permanent wiring is recommended for factories. The entire method of mounting them can be arranged to suit the individual preference of the purchasers. The dipping pans are shipped all ready to place in a table and connect up, and the tables for mounting the pans can be procured or made by the purchaser without difficulty.

Electrical Supplies for the Navy Department.

The Bureau of Supplies and Accounts will open bids in Washington, D. C., on October 20 for the following electrical material: Sixteen hundred and fifty incandescent lamps for delivery at Annapolis, Md.; twelve starting panels for delivery at Norfolk, Va.

Bids will be opened on October 27 for 100 dry batteries, 3,000 wood blocks, nine dozen brushes, 20,000 feet lighting cable, 12,000 carbons, 4,000 feet silk-covered cord, miscellaneous fittings, miscellaneous inner and outer globes, 3,000 wire lamp guards, 200 insulators, 19,100 incandescent lamps, four direct-current motors, 2,300 porcelain receptacles, 35,000 feet rubber-covered wire, and 8,000 feet twisted wire, for delivery at Brooklyn, N. Y.; one Wheatstone bridge, six desk-type fans, miscellaneous electrical supplies for delivery at Annapolis, Md.; miscellaneous electrical supplies for delivery at Norfolk, Va.

New Holophane Reflectors for Tungsten Lamps.

The Holophane Company, New York city, has completed the designs for an entirely new line of reflectors for tungsten lamps.

The new tungsten reflectors are of three types which will be known to the trade as the "Extensive," "Intensive" and "Focusing" types. In appearance all are similar to the original "bowl type" Holophane reflectors designed for Gem lamps, but each of the three new types above named gives a distinctive distribution of light. In the preliminary engineering work connected with these new types, the engineering department, Holophane Company was ably assisted by A. J. Sweet, of the Westinghouse company.

In the designing of the reflectors an entirely new principle was evolved—that of the "merging prism." As is well known, Holophane reflectors having a continuous prism from the collar to the edge lose considerably in efficiency, owing to the fact that the prism is much larger at the bottom than at the neck. To prevent this the Holophane Company designed what is known as the "equal prism" reflectors, in which prisms of practically equal size are run in several banks from neck to top. In the new types, instead of an abrupt step between the banks of prisms the several banks are merged one into the other, which not only adds greatly to the beauty of the reflectors but at the same time gives the maximum of efficiency.

The new "merging prism" reflectors are made for forty, sixty and 100-watt tungsten lamps, three types, as above described, for each size of lamp. This makes a very compact line and one which is uniform in appearance.

New Holophane Reflector.

A new Holophane bulletin descriptive of this line of high-efficiency reflectors is now in press. In addition to technical description, photometric curves, etc., this bulletin will contain a few simple rules by following which even a novice may be sure of selecting proper size of lamps and correct Holophane reflector and of spacing these rightly in any ordinary lighting installation. The new "flux of light" method of calculating illumination, it is stated, enables the Holophane Company's engineers to reduce the salient features of practical illuminating engineers to a few simple "rules of thumb" which are applicable wherever the installation is not complicated by æsthetic or architectural difficulties or restriction.

The new line will be handled not alone by the Holophane Company, but also by the General Electric Company, Westinghouse Electric and Manufacturing Company, Franklin Electric Manufacturing Company and the companies comprising the National Electric Lamp Association.

Current Electrical News

DOMESTIC AND EXPORT.

ARKANSAS INTERURBAN PLANNED—A project to build a third-rail interurban line from Little Rock south to Sheridan, branching out from that place to Hot Springs and Pine Bluff, all in Arkansas, the entire road to be built at an actual cost of $2,700,000, has been planned by the Central Arkansas Electric Railway Company, of Pine Bluff, and is now being considered, it is stated, by Chicago capitalists, who will probably reach a decision in regard to the project by the first of the next year. Preliminary surveys and plans for the railroad have already been made. Sheridan is thirty or thirty-five miles south of Little Rock. Hot Springs is about forty-five miles west of Sheridan and Pine Bluff about thirty miles east of the same place.. A. M. Van Auken is chief engineer of the company.

TELEPHONE COMPANIES UNITE—At a meeting of the stockholders of the United States Telephone Company, the Cuyahoga Telephone Company, of Cleveland, Ohio, and the Citizens' Telephone Company, of Columbus, Ohio, the three companies were merged. The new company, which has not been named, will act as an operating company with a capitalization of between $5,000,000 and $10,000,000 and will take over the three independent companies on a lease for 999 years. Other Ohio independent companies will, it is stated, be added from time to time. The merger places under the control of the operating company over fifty per cent of the independent telephones and about 75,000 of the 325,000 telephones in the state of Ohio. The United States company has extensive long-distance lines in Ohio and adjoining states.

MEXICAN ELECTRICAL NOTES—The Guanajuato Power and Electric Company has arranged for the construction of a new line eighty-five miles in length to be used as a reserve line in case of accident. The wire for this new line will be strung on steel towers beginning at Penjama and terminating at the station at Guanajuato. There will be substations every twelve miles. Work will be begun at once. The Atotonilco Light and Power Company, a concern recently organized by Guadalajara men to furnish current for light and power in the town of Atotonilco, the centre of the orange district of Jalisco, has placed an order with Siemens-Schuckertwerke, of Berlin, for hydroelectric machinery, transmission lines and substation equipment. The value of the order is $14,000. The Guadalajara company will utilize a waterfall near the town.

OMAHA MEN INCORPORATE INTERURBAN COMPANY—The Nebraska Traction and Power Company, of Omaha, is the name of a new corporation that has filed articles with the secretary of state under the interurban law passed two years ago. It has an authorized capital stock of $2,000,000 and the incorporators are: Mel Uhl, N. P. Dodge, Jr.; William D. Crist, F. A. Howard and J. F. Emmert, all of Omaha. The company proposes to build a line from South Omaha in a westerly direction through Douglas County to the town of Ralston, thence in a southerly direction through Sarpy County and in a northerly direction from Ralston through the counties of Douglas, Dodge, Washington, Burt, Cuming, Thurston and Dakota, Neb. It is to be either a single or double-track road, and operated by electricity or any other motive power. The company proposes to operate telephone or telegraph lines and to transmit power, light and heat for itself or other persons, and to carry passengers, baggage, express and mail. The $2,000,000 capital stock is to be divided into shares of $100 each, 15,000 shares to be preferred and 5,000 common.

NEW ELECTRIC COMPANY FILES ARTICLES—The Des Moines (Iowa) Electric Company has filed articles of incorporation. The charter of the company gives it the right to own lighting plants and all appurtenances and property in connection therewith and railways. Its capital stock is $5,000,000, of which $3,500,000 is common and the rest preferred. Of the common stock fourteen shares, representing $1,400 par value, has been issued. None of the preferred has been issued. The officers of the company are: J. Berry, president and treasurer; Lewis A. Burleigh, clerk; Joseph Williamson, Ernest L. McLean, Walter M. Sanborn, E. M. Leavitt and M. M. Spinney, with the officers named, forming the board of directors. All of the officers except Mr. Leavitt of the board live at Augusta, Me. He lives at Winthrop. Five of the common stock shares of the company are held in New York city, six at Augusta, Me., and one each at Ridgewood, N. J., at Brooklyn, and at Winthrop, Me.. The purpose of the new organization, which now has a right to do business in Iowa, is to take over the Edison Light Company, of Des Moines. The Edison Light Company operates under the laws of the state of Iowa.

IDAHO-OREGON LIGHT AND POWER COMPANY—All business of the subsidiary companies of the Idaho-Oregon Light and Power Company will hereafter be transacted in the name of the owning company, recently formed for the purpose of perfecting a merger. The Oregon-Idaho company, which is incorporated with a capital stock of several million dollars, and in which the Mainland brothers, of Oshkosh, Wis., are interested, has now absorbed the Capital Electric Light, Motor and Gas Company, the Boisé-Payette River Electric Power Company, the Electric Power Company, of Boisé; the Interstate Light and Power Company, of Meridan, and the Emmett Electric Light Company, of Emmett. This company is at present furnishing light and power to Boisé, South Boisé, Pearl, Horseshoe Bend, Neal mining district, Meridian, Emmett and Ontario, Ore., and is constructing lines to New Plymouth and Weiser. Power is supplied from the Horseshoe Bend plant on the Payette River, the Barber plant on the Boisé River and a smaller plant on the Ridenbaugh canal in South Boisé, with a total capacity of 5,000 horse-power. The company is building a large power plant on the Snake River, sixty miles north of Huntington, which will have a capacity of 30,000 horse-power. One hundred and thirty miles of transmission line is now supplying the district south and east of Weiser, Ida., and some 200 additional miles will be built next year.

NEW MANUFACTURING COMPANIES.

RICHMOND, VA.—The corporation commission has issued a charter to the Southern Electric and Manufacturing Corporation, Richmond, with B. B. Brauer, president; E. D. Moore, vice-president, and J. W. Church, secretary and treasurer—all of Richmond. The maximum capital is $50,000; minimum, $25,000. The company will manufacture and sell the Brauer automatic time switch.

SEATTLE, WASH.—The United Wireless Telegraph Company has purchased the factory of the Nelson Metal Specialties Company. It will be taken over by the operating department of the company, headed by C. C. Galbraith, and work will begin at once in the manufacture of wireless apparatus for use on the Pacific Coast. The first wireless instruments to be turned out will be for a demonstrating wireless station at the Spokane fair.

SALINA, KAN.—The Anderson Electric and Manufacturing Company has been incorporated with a capital of $200,000 to manufacture the inventions of John Anderson, of Salina, Kan., including the Anderson lockout system for telephone circuits and other telephonic appliances and improvements. The officers are: R. T. Blair, of Emporia, Kan., president; C. E. Carlson, of McPherson, Kan., vice-president; R. G. Henderson, of McPherson, secretary, and J. K. Bremyer, of McPherson, treasurer. The temporary headquarters of the company are at Salina.

DATES AHEAD.

American Society of Municipal Improvements. Annual meeting, Atlantic City, N. J., October 20-23.

American Electrochemical Society. Fall meeting, New York city, October 30-31.

Association of Car-Lighting Engineers. First annual meeting, Chicago, Ill., November 18.

National Society for the Promotion of Industrial Education. Annual meeting, Atlanta, Ga., November 19-21.

American Roentgen Ray Society. Annual meeting, New York city, December 28-30.

ELECTRIC LIGHTING.

SHERMAN, TEX.—The city has voted on the issuance of $16,000 light-betterment bonds.

OTTAWA, ILL.—Ground has been broken for the interurban between Streator and Grand Ridge.

GADSDEN, ALA.—The Sand Mountain Electric Company has been organized to install an electric light plant at Albertville.

WAVERLY, IOWA—The municipal light and water plants at Waverly were destroyed by fire on September 22, involving a loss of $50,000.

NASHVILLE, TENN.—The Chattanooga Electric Company, chartered under the laws of Maine with $3,000,000 capital, has filed its charter.

FLORESVILLE, TEX.—The city council has granted permission to Dr. Largen, of San Antonio, to establish an electric light plant at Floresville.

WINCHENDON, MASS.—The town selectmen have granted the Connecticut River Transmission Company permission to erect towers for the support of high-tension wires.

EL PASO, TEX.—Richard Caples and W. B. Latta have been granted a franchise to build an electric line through El Paso County. The grantees must build at least ten miles of road in two years.

SPRINGFIELD, ILL.—The Springfield, Clear Lake & Rochester Interurban Railway Company has been given the right to operate cars over the lines of the Springfield Consolidated Railway Company.

DOUGLASVILLE, GA.—M. L. Hathcock has purchased the old Arnold mill property and it is said will build a dam and generate sufficient power to operate an electric plant to supply nearby towns.

BALTIMORE, MD.—At the annual meeting of the Consolidated Gas, Electric Light and Power Company, of Baltimore, the seventeen retiring directors were re-elected, with the addition of W. H. Cassell.

LORAIN, OHIO—The service board has decided to employ F. C. Werk, a Cleveland contractor and engineer, to submit preliminary estimates on a municipal lighting plant for the city as requested by the council.

KENNETT, CAL.—The new power line of the Northern California Power Company, directly from the Volta power plant to Kennett, a distance of forty miles, is in operation. The line will carry 60,000 volts.

STEVENSON, ALA.—The board of aldermen has granted an electric light franchise to Fred A. Howe, of Huntsville. The business men are subscribing liberally for lights, both in their homes and business houses.

SEATTLE, WASH.—The finance committee of the city council has authorized Superintendent L. B. Youngs, of the light and water department, to complete the present extension of the lighting system from Cedar Lake to the city.

FREDERICKSBURG, VA.—Work on the new steel dam of the Fredericksburg Power Company on the Rappahannock River, above this city, is progressing rapidly. The first section of the dam will be completed within the next thirty days.

MONTGOMERY, ALA.—General Manager R. L. Pultz, of the Birmingham & Gulf Navigation Company, says that it is the intention of the company to build electric lines from Gadsden to Birmingham and Tuscaloosa in a short time.

WOONSOCKET, R. I.—The Woonsocket Realty Company has sold to the Woonsocket Electric Machine and Power Company valuable water rights on the old Ray Mill property. The company will use the power for operating its No. 2 station.

MILLEN, GA.—J. B. McCrary & Company, of Atlanta, have been awarded the contract for a lighting plant and water works for Millen. W. O. Lumpkin will have charge of construction and will commence work as soon as material can be had.

OGDEN, UTAH—The preliminary work on the proposed power plant in South Fork cañon has been started. It is the purpose of the builders to put in a pipe-line and a plant that will generate 10,000 horse-power which will be brought to this city by a pole-line.

PONTIAC, MICH.—The title to the Clinton River Power Company at Amy has passed into the hands of William H. Osmun. Mr. Osmun says he expects to utilize the Clinton River to secure 1,000 horse-power. Electric light and power will be furnished to Pontiac.

DURHAM, N. C.—The East Durham Cotton Mills announce that as soon as the installation of the new machinery can be made the mills will be run by electric power. Two of the engines with eight boilers will be removed for the erection of new boiler and engine houses. The change will involve an outlay of $75,000 or more.

LEBANON, PA.—A meeting of local capitalists was held in this city for the organization of a trolley company. A line will be built from Womelsdorf, Berks County, to Campbelltown, Lebanon County. A committee was appointed to secure a charter and to have surveys made. Most of the rights of way of the company have been secured.

ASHBURN, GA.—Bonds to the amount of $50,000, issued by the city of Ashburn, for the purpose of putting in electric lights and waterworks, have been sold and the contract let for the work, J. B. McCrary, of Atlanta, being the successful bidder. The work will be commenced as soon as the necessary preparations can be made.

ALBION, N. Y.—At a meeting of the village board of trustees a resolution was passed entering into a contract with the Albion Power Company to furnish the village with sixty-eight street arc lamps at $70 each. The company has expended $20,000 in improving its plant. Hereafter this village will receive an all-night service.

SACRAMENTO, CAL.—Work is progressing on the new dam of the Folsom Power Company on South Silver Creek in El Dorado County, and a force of men is employed clearing the right of way which has been secured over state and private lands. It is estimated that the new plant will give the company an additional 10,000 horse-power. The new plant will be installed within the next few months.

MONTPELIER, VT.—The Molly Falls Electric Light and Power Company has purchased all the right and interest which the late Perrin P. Kellogg, of Whitefield, N. H., had in the Molly Falls water power under a lease and contract given to Mr. Kellogg in 1903. The company leased its water rights and privileges for a period of ninety-nine years at $900 a year, reserving 400-horse-power with which to furnish lights to Cabot, Plainfield, Marshfield and North Montpelier.

COLUMBUS, OHIO—At meetings of the board of directors of the several companies concerned, held in Springfield, the merger of the People's Light, Heat and Power Company and the Home Light and Power Company, of Springfield, under the new name of the Springfield Light, Heat and Power Company was completed. Officers of the new company were provided for and the first payment of $50,000 made on the properties of the Home company. The new company will issue $500,000 of bonds, to be sold at ninety, the proceeds of which will be used to purchase the Home plant and retire the outstanding bonds of the People's company. An exchange of stock will be made for that of the People's company now outstanding. The capitalization of the new company is $1,000,000.

MISSOULA, MONT.—The Idaho Railway and Navigation Company has been incorporated in Washington with a nominal capital of $100,000 to build an electric line from Dead Man's Creek, in the northern part of Garfield County, through Asotin County and around the Blue Mountain range to the Seven Devils mining district, in Idaho, seventy-seven miles. The incorporators are: D. Van Arsdale, president; Samuel L. Tate, secretary; C. W. Hadley, general manager; M. Wood, engineer; Lester P. Edge and Fred Larson. Eleven directors and a council of five will be elected in November, at which time it is expected to have twenty miles of line completed. The single-phase system will be installed. The power-house, to be erected on Snake River, and the distributing stations, will cost $64,000, while the line will cost $40,000 a mile. The line will tap coal, cement and mineral deposits, and also run through agricultural, orchard and stock districts, not now served by railroads.

PERSONAL MENTION.

MR. PATRICK B. DELANY has been awarded the Elliott-Cresson gold medal for his invention of a system of rapid telegraphy.

MR. ALLEN L. HASSE has resigned as sales manager of the Pierce Company, and joined forces with the Harvard Electric Company, Chicago, Ill., as general sales manager.

MR. G. L. CONKLIN, who has been assistant manager of the Mankato Electric Traction Company, of Mankato, Minn., for some time, has been made general manager of the company, succeeding H. E. Hance, who will become connected with a proposed electric road to St. Peter.

MR. FRED W. GODFREY, for the past six years representing the Bryan-Marsh Company, and manager of the Cincinnati, Ohio, branch for the past two years, has organized the Godfrey Sales Company, with an office in the Perin Building, Cincinnati. Mr. Godfrey will continue to represent the Bryan-Marsh Company, as well as the Ambos-Cudmore Company, of Cleveland, Ohio. Among the lines represented by the Godfrey Sales Company are Bryan-Marsh Company lamps, Duncan wattmeters, Duncan transformers, Wheeler reflectors, Weston instruments, Bristol recording instruments, Aladdin specialties, Detroit rubber-covered wire, Hartford automatic time switches, Condit circuit-breakers and oil switches.

NEW PUBLICATIONS.

CALCULATIONS FOR POWER DISTRIBUTION—The Association Amicle des Anciens Elèves has reprinted in pamphlet form the treatise by J. H. Jacobsen, entitled "Calcul Electrique et Mécanique des Distributions d'Energie."

DEPARTMENT OF EDUCATION, CITY OF NEW YORK—The Department of Education of the city of New York has published its announcement of public lectures to be given in Manhattan and The Bronx for the October-December course. The department has also published the annual report of the supervisor of lectures of the board.

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES—The Brooklyn Institute of Arts and Sciences has published its prospectus for 1908-1909. In science the department of electricity will conduct a series of illustrated lectures on electrical engineering on Thursday evenings. Professor Samuel Sheldon is president, and Hubert S. Wynkoop is secretary, of the department. The department of engineering will conduct a series of illustrated lectures on engineering on the third Thursday evening of each month. Nelson P. Lewis is president, and Arthur S. Tuttle is secretary, of the department. The central office of the institute is now established in the Academy of Music on Lafayette avenue.

NEW INCORPORATIONS.

AUSTIN, TEX.—The Godley Independent Telephone Company, Godley, Johnson County. $3,200. Incorporators: B. B. Robinson, J. A. Dalton, C. D. Odom, John R. Beaver.

MADISON, WIS.—Cady Telephone Company, village of Wilson, St. Croix County. $5,000. Incorporators: S. L. Pickett, G. W. La Pointe, Jr., Martin D. Erickson, Frank Smith, David Cushing and Peter Simonson.

MOSCOW, IOWA—E. S. Johnson Company, of Davenport, Iowa, $100,000. To do general construction work, operate and build manufacturing plants, deal in stocks and real estate and build and operate steam and interurban railways. Officers: E. S. Johnson, president; John C. Sessor, vice-president, and Julius E. Burmeister, secretary and treasurer.

HARRISBURG, PA.—Lost Creek Valley Rural Telephone Company. $5,000. To build a line from Mifflin to Selins Grove and Middleburg; from Mifflin to Blain, Newport, Millerstown and New Bloomsfield, and from Mifflin to Liverpool. Incorporators: A. J. Beyers, Mifflin; H. J., J. H. and Leo Shallenberger, and A. W. Herr, McAllisterville; J. O. Smith and J. H. Carney, Bunkertown.

ELECTRICAL SECURITIES.

The market suffered during the week, by reflection from foreign financial centres, from the disturbances created by the boiling over of the Balkan cauldron. For a few days even the political situation here was overshadowed, but when the first-mentioned matters were analyzed and discussed it remained to be seen that the latter was still the predominating factor in stock market influences. Industrial betterment seems to be more generally recognized, and with the better prices than usual prevailing and posted for futures it appears as if our agriculturists would be richer by some billion of dollars when the season's crops shall have been harvested and disposed of.

Dividends have been declared upon the following electrical securities: Electric Bond and Share Company; regular quarterly dividend of 1¼ per cent on the preferred stock, payable November 1. Commonwealth Edison Company; quarterly dividend of 1½ per cent, payable November 2 to stock of record October 20. The rate previously was 1¼ per cent quarterly. Central District and Printing Telegraph Company; regular quarterly dividend of 2 per cent, payable October 31 to stock of record October 24. American Light and Traction Company; regular quarterly dividends of 1½ per cent on the preferred stock and 1¾ per cent on the common stock, both payable November 2. Books close October 21 and reopen November 2. Mexican Telephone and Telegraph Company; regular semi-annual dividend of 2½ per cent, payable November 2 to stock of record October 16. Edison Electric Illuminating Company of Boston; regular quarterly dividend of 2½ per cent, payable November 2 to stock of record October 15. East St. Louis & Suburban Company; regular quarterly dividend of 1¼ per cent on the preferred stock, payable November 2 to stock of record October 15. Columbus Railway Company; regular quarterly dividend of 1¼ per cent on the preferred stock, payable November 2 to stock of record October 15.

ELECTRICAL SECURITIES FOR THE WEEK ENDED OCTOBER 10.

New York:	*Closing.*
Allis-Chalmers common	11¼
Allis-Chalmers preferred	35½
Brooklyn Rapid Transit	48¼
Consolidated Gas	145¼
General Electric	140
Interborough-Metropolitan common	10½
Interborough-Metropolitan preferred	31
Kings County Electric	125
Mackay Companies (Postal Telegraph and Cables) common	68
Mackay Companies (Postal Telegraph and Cables) preferred	67¾
Manhattan Elevated	135
Metropolitan Street Railway	26
New York & New Jersey Telephone	110
Western Union	58½
Westinghouse Manufacturing Company	74

The annual meeting of the Manhattan Railway Company will be held at 195 Broadway, New York city, on November 11.

Boston:	*Closing.*
American Telephone and Telegraph	126¾
Edison Electric Illuminating	225
Massachusetts Electric	51
New England Telephone	119½
Western Telephone and Telegraph preferred	75

The number of stockholders of the American Telephone and Telegraph Company now amounts to better than 25,500, an increase of over 2,000 since the beginning of the year. This is a gain of 8 per cent in the nine months. Less than two years ago the American Telephone Company had barely 18,000 stockholders, so that there has been an average yearly increase of over 3,500 names in the past two years.

Philadelphia:	*Closing.*
Electric Company of America	9⅞
Electric Storage Battery common	34½
Electric Storage Battery preferred	34½
Philadelphia Electric	10
Philadelphia Rapid Transit	22⅜
United Gas Improvement	86

Chicago:	*Closing.*
Chicago Telephone	125
Commonwealth Edison	108¼
Metropolitan Elevated preferred	40
National Carbon common	67
National Carbon preferred	110

For September the Chicago Telephone Company gained 2,095 telephones, making a gain for nine months of 21,443, and a total in service of 175,075.

The annual meeting of the Commonwealth Edison Company will be held November 9. Proxies run to Robert T. Lincoln, Samuel Insull and William G. Beale.

ELECTRIC RAILWAYS.

WACO, TEX.—The survey of the proposed Waco, Temple & Marlin interurban has been begun out of Temple. Construction will start in a few weeks.

MILWAUKEE, WIS.—The first through electric car over the Chicago & Milwaukee Electric road, from Evanston to Milwaukee, arrived at the southern city limits of Milwaukee on September 30.

MONTGOMERY, ALA.—It is understood that in a short time the Montgomery Traction Company will begin the work of generally extending its lines. At a meeting of the directors, held in Philadelphia, it was decided to take up the matter.

WEATHERFORD, TEX.—Mayor Moseley announces the completion of the Weatherford interurban survey subscriptions. The expenses to survey the line to Mineral Wells were guaranteed by Fort Worth, Mineral Wells and Weatherford. The work will cost $3,500.

SPOKANE, WASH.—Announcement is made that about the middle of December the new Brookville-Puyallup branch of the Puget Sound Electric Railway will be opened for traffic. The completion of this line of electric railroad will enable the people of the Puyallup Valley to come direct to this city.

DOWAGIAC, MICH.—Articles of incorporation have been filed for the Dowagiac Railway Company, the incorporators being C. K. Minary, H. S. Grey and Henry Mason, of Benton Harbor, and the capital stock being $200,000. These gentlemen are identified with the Benton Harbor & St. Joseph Street Railway and Power Company, and it is their purpose to extend the electric line from Eau Claire to Dowagiac.

BUFFALO, N. Y.—The last link connecting Erie with Buffalo by trolley will be completed by January 1, 1909, according to General Manager Calisch, of the Buffalo & Lake Erie Traction Company. The only gap now remaining is at Westfield, and this will soon be closed under action taken by the village taxpayers, who have voted $35,000 toward the expense of a viaduct to connect the hills on the opposite sides of Chautauqua Creek.

SPRINGFIELD, ILL.—The construction of the interurban line from Springfield to Quincy by way of Petersburg is an assured fact, according to the officials of the Springfield-Rochester line, who have charge of the proposed new line. Practically all of the right of way has been secured, and grading from the entrance of the Zoo park west has been carried a considerable distance. The extension of the city street railway line to the Zoo park next spring will assure an entrance into the city for the new line.

GREELEY, COL.—At a meeting of the directors of the Burlington Interurban Railway Company, which is building a line from Hudson, on the Burlington, to Greeley, Pleasant Valley, Ault and Fort Collins, the resignation of F. O. Olson as president was accepted and John P. Klug, one of the wealthiest stockmen and land owners in Weld County, was elected to the vacancy. C. I. Moore, a merchant of Greeley, was elected treasurer. All surveys are made and grading is expected to be begun in a few days.

GUTHRIE, OKLA.—A charter has been issued by the secretary of state to the Oklahoma, Kansas & Missouri Interurban Railway Company, of Miami, with $200,000 capital stock. The company proposes to build an interurban line from Miami through Hattonville and Lincolnville to Baxter Springs, Kan., twenty-two miles, at an estimated cost of $20,000 per mile. The proposed line goes through the heart of the Miami-Baxter zinc field and proposes to haul ore as well as passengers. The incorporators are: Franklin Smith, of Joplin, Mo.; F. O. Freeman, R. H. Holton, John Hall and D. W. Cooter, of Miami.

BALTIMORE, MD.—Work on the new line of the Baltimore, Halethorpe & Elkridge Electric Railway is being pushed, and it is probable that cars will be in operation over the route early in December. The portion of the road now in course of construction reaches from the terminus of the Wilkens avenue car line to Halethorpe, a distance of three and a half miles. The line branches off from Wilkens avenue and runs almost parallel with the Pennsylvania tracks to Halethorpe. The road is being built over a private right of way, and the development will be carried only to Halethorpe for the present. The total cost of the line to Halethorpe will be about $125,000, and when completed it will be operated by the United Railways.

STOCKTON, CAL.—The electric road between Stockton and Modesto will be commenced at an early date, the financing of the road having been completed by Morris L. Brackett, of New York. Surveyors are now in the field, running the first lines between the two cities. It is proposed to build the road from the water front in Stockton out Lincoln street alongside the French Camp toll road through French Camp, Manteca, Ripon and on to Modesto. The South San Joaquin Improvement Company some weeks ago closed up the rights of way with the farmers on the understanding that they were to be transferred to the first corporation or firm that would build the road. The company turned over these rights of way to Brackett, who interested $500,000 capital.

INDUSTRIAL ITEMS.

THE BIRD-ARCHER COMPANY, New York city, has published a bulletin devoted to boiler troubles and their prevention.

STANLEY & PATTERSON, INCORPORATED, 23 Murray street, New York city, is distributing a folder calling attention to the advantages of Marshall fuse plugs.

THE RAIL JOINT COMPANY, New York city, announces that at the close of September business the total output of its base-supporting rail joints amounted to over 50,000 miles equipped during the past fourteen years.

THE FRANKLIN ELECTRIC MANUFACTURING COMPANY, Hartford, Ct. has published some interesting information in its bulletin No. 7, concerning the Franklin tungsten lamp. Copies of this bulletin will be furnished to those interested upon request.

THE HILL CLUTCH COMPANY, Cleveland, Ohio, manufacturer of power-transmitting, elevating, conveying and cement machinery, has issued a catalogue devoted to its collar oiling bearing. Copies of this catalogue will be furnished to those interested upon request.

THE TRUMBULL ELECTRIC MANUFACTURING COMPANY, Plainville, Ct., in the October issue of "Trumbull Cheer," gives some interesting information concerning the manufacture of switch clips, and illustrates the Trumbull type "A" switch for 4,000 amperes, 250 volts.

THE NERNST LAMP COMPANY, Pittsburg, Pa., has issued bulletin B, devoted to a description and illustrations of the Westinghouse Nernst multiple-glower lamps. These new types of Nernst lamps have attracted a great deal of attention, and the data contained in this bulletin will be found of value by all those interested in problems of illumination.

THE TAUNTON-NEW BEDFORD COPPER COMPANY, Taunton, Mass., has purchased the manufacturing interests of the W. S. Hill Electric Company, of New Bedford, Mass. The Hill company will become the electrical department of the Taunton-New Bedford Copper Company, and the Hill factory at New Bedford will be used until new quarters are prepared in Taunton. Charles S. Mendell, formerly treasurer and general manager of the W. S. Hill Electric Company, will be manager of the electrical department.

THE CONSOLIDATED SUPPLY COMPANY, 321 Dearborn street, Chicago, Ill., has issued its loose-leaf catalogue No. 15. In distributing this catalogue the company calls especial attention to the patented metal car roof which has just been placed on the market after having been tested out on a car for the past five years. The roof has special features fully covered by letters patent. The company is also calling attention to a new malleable tie plate which has had considerable sale, and on which patent is now pending.

THE WHEELER CONDENSER AND ENGINEERING COMPANY, Carteret, N. J., manufacturer of the well-known Wheeler surface, jet and barometric condensers and Wheeler centrifugal pumps and water-cooling towers, announces that Harry Pennington, of the Lumbermen's National Bank Building, Houston, Tex., has been appointed its agent for Texas. Mr. Pennington has been engaged in the practice of mechanical engineering in Houston for a number of years, and has been identified with many of the large

enterprises in that section. He is at present consulting engineer for the Galveston waterworks, engineer for Houston and Fort Bend counties, president of the Southwestern Engineers' and Architects' clubs, and chief engineer of the state of Texas.

THE GENERAL ELECTRIC COMPANY, Schenectady, N. Y., has published an attractive bulletin entitled "Steady *versus* Unsteady Voltage." This bulletin, No. 4,619, refers particularly to the use of automatic feeder regulators for incandescent lighting on alternating-current systems. Bulletin No. 4,622 is devoted to a description and illustrations of polyphase maximum-watt indicators, and bulletin No. 4,616 contains a detailed description of high-voltage type H transformers. An attractive booklet, descriptive of the General Electric "Multi-catch" socket has been issued, and bulletin No. 4,618 describes the company's new form PB polyphase generator for use in small power plants and isolated lighting plants where rapidly increasing inductive loads and low power-factors are encountered.

Record of Electrical Patents.

Week of October 6.

900,165. PROGRESSIVE CUTOUT MECHANISM. Jay H. Hall, New York, N. Y., assignor to the Electric Controller and Supply Company, Cleveland, Ohio. Filed March 18, 1908. Means are provided for rendering the cutout driving member inoperative for a predetermined travel of the driving mechanism after each cutout operation.

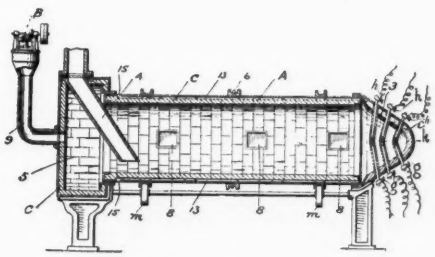
900,169. APPARATUS FOR ELECTROPLATING METAL SHEETS. Henry L. Hollis, Chicago, Ill. Filed August 1, 1907. Means are provided for conveying sheets of metal vertically from one end of the vat to the other.

900,192. ELECTRIC FURNACE. Robert McKnight, Pittsburg, Pa. Filed August 28, 1906. A rotating tubular furnace is heated by passing a draft through an electrically heated firebox.

900,207. ELECTRIC FURNACE. James H. Reid, Cornwall, Ontario, Canada, assignor of one-half to Stephen Lemuel Tingley, Ottawa, Canada. Filed April 1, 1907. The material under treatment comes in contact with serially-arranged electrodes, and means are provided for varying the chemical conditions in each electrode chamber.

900,208. ELECTRIC LAUNDRY IRON. Earl H. Richardson, Ontario, Cal., assignor to Pacific Electric Heating Company, Ontario, Cal. Filed December 2, 1907. There is a thermic fuse in circuit with the heating unit.

900,214. VENT-VALVE FOR AUTOMATIC TRAIN STOPS. Hiram G. Sedgwick, Mill Valley, Cal. Filed June 29, 1907. Means are provided for giving the valve a differential movement.



900,192.—ELECTRIC FURNACE.

900,215. AUTOMATIC TRAIN STOP. Hiram G. Sedgwick, Mill Valley, Cal. Filed September 4, 1907. Means are provided for manually operating the circuit-breaker and for automatically restoring the circuit-breaker to a normally closed position. A registering device is operated every time the circuit-breaker is released.

900,216. AUTOMATIC TRAIN STOP. Hiram G. Sedgwick, Mill Valley, Cal. Filed October 28, 1907. An eccentrically geared mechanism imparts to the valve a quick and slow movement.

900,217. AUTOMATIC TRAIN STOP. Hiram G. Sedgwick, Mill Valley, Cal. Filed January 4, 1908. A supplemental vent is operated after the main vent is closed. Means are provided for manually closing this supplemental vent.

900,238. TELEGRAPH KEY. James Z. Tucker and Lawrence V. Tucker, St. Louis, Mo. Filed December 16, 1907. The throwing-in switch is adjacent to the key-button.

900,266. HOOD AND REFLECTOR. George Cutter, South Bend, Ind. Filed October 30, 1907. A weatherproof cluster reflector.

900,273. ELECTRIC RAILWAY SIGNAL SYSTEM. Thomas M. Freeble, Latrobe, Pa. Filed June 7, 1907. A lever arm and contacts are actuated by the passage of the trolley wheel.

900,278. ELECTROLYTIC ALTERNATING-CURRENT RECTIFIER. Arthur S. Hickley, Manasquan, N. J. Filed November 12, 1907. The electrolyte contains a substance for preventing oxides and precipitates forming and collecting in the cell.

900,279. ELECTROLYTIC ALTERNATING-CURRENT RECTIFIER. Arthur S. Hickley, Manasquan, N. J. Filed January 16, 1908. One electrode extends across the cell near the bottom and through one wall.

900,289. SYSTEM OF CONTROL FOR ELECTRIC MOTORS. Benjamin G. Lamme, Pittsburg, Pa., assignor to Westinghouse Electric and Manufacturing Company. Filed December 4, 1905. An auxiliary field magnet winding remains open-circuited when the motor is operated by alternating currents, but is closed-circuited on itself when the motor is operated by direct currents.

900,292. ELECTRIC CURLING-IRON HEATER. Wynn Meredith, San Francisco, Cal., assignor to Pacific Electric Heating Company, Ontario, Cal. Filed September 25, 1907. The heating element is adapted to receive a curling iron.

900,295. ELECTRIC HEATING DEVICE. William C. Mortensen, Salt Lake City, Utah, assignor of one-half to Joseph R. Harris, Woodruff, Ida. Filed April 6, 1908. Resistance lamps are contained between an outer and inner cylinder.

900,304. ELECTROMAGNET FOR TELEGRAPHONES. Peder O. Pederson and Valdemar Poulsen, Copenhagen, Denmark, assignors to American Telegraphone Company. Filed April 9, 1902. Means are provided for directing an effective number of lines of force outside the coil.

900,320. CIRCUIT-INTERRUPTER. Cullen B. Snell, Bradford, Mass. Filed February 18, 1907. The circuit-operating device is yielding supported by a plurality of contact springs.

900,340. APPARATUS FOR ELECTROPLATING. John A. Yunck, South Orange, N. J. Filed November 8, 1906. The cathode, or negative pole, is adapted to hold an incandescent electric lamp. The anode has its operative face shaped to conform to the adjacent surface of the lamp bulb.

900,344. MAGNETIC OPERATING MEANS FOR CAMERA SHUTTERS. Arnold Bartels, Los Angeles, Cal., assignor of one-half to Rosa Hug, Los Angeles, Cal. Filed June 10, 1907. The shutter-operating arm is actuated by means of an electromagnet.

900,359. CHANGING BATTERIES IN ELECTRICALLY PROPELLED VEHICLES. Albert J. Doty, Mount Vernon, N. Y., assignor of one-half to Charles Berg, Philadelphia, Pa. Filed February 3, 1908. Battery trucks are disposed on opposite sides of the vehicle, in position to deliver a battery to one side of the battery receptacle, and receive a battery from the other side.

900,370. BLOCK-SIGNALING SYSTEM. John S. Holliday, Wilkinsburg, Pa., assignor to the Union Switch and Signal Company, Swissvale, Pa. Filed February 21, 1908. The track rails are electrically continuous for all currents and equipped with synchroscopic relays having a movable element connected across the track rails.

900,372. ANTISEPTIC MOUTHPIECE FOR TELEPHONES, SPEAKING TUBES, ETC. Milton S. Hufschmidt, San Francisco, Cal. Filed April 7, 1906. A porous disc extends transversely across the interior of the mouthpiece.

900,382. MOISTURE-PROOF CASE FOR INSULATED WIRES. Adrian L. Joynes, Paducah, Ky., assignor of one-third to Charles L. Meyers, St. Louis, Mo. Filed June 4, 1906. A terminal head adapted to be hermetically sealed by screw-threaded rims and sectional washers.

900,386. TELEPHONE TRANSMITTER. Adolph G. Kaufman and Leopold J. Lippmann, New York, N. Y., assignors to American Callaphone Company, New York, N. Y. Filed January 19, 1907. The diaphragm is actuated by a plurality of mouth-pieces.

900,387. TELEPHONE RECEIVER. Adolph G. Kaufman and Leopold J. Lippman, New York, N. Y., assignors to American Callaphone Company, New York, N. Y. Filed February 7, 1907. A loud-speaking receiver.

900,392. SOUND RECORDING AND REPRODUCING INSTRUMENT. Georg Kirkegaard, New York, N. Y., assignor to Stilson Hutchins, Washington, D. C. Filed November 18, 1899. Means are provided for successively magnetizing a number of bodies in accordance with sound waves and a diaphragm subjected to the successive action of said bodies.

900,404. TELEPHONE DESK SET. Rap H. Manson, Elyria, Ohio, assignor to Dean Electric Company, Elyria, Ohio. Filed August 23, 1907. Means are provided within the upright for securing the upper hinge member to the base.

900,416. ELECTRIC GLOW LAMP. Walther Nernst, Göttingen, Germany, assignor, by mesne assignments, to Nernst Lamp Company, Pittsburg, Pa. Filed March 29, 1898. The element comprises a mixture of zirconium oxide and another refractory metal oxide.

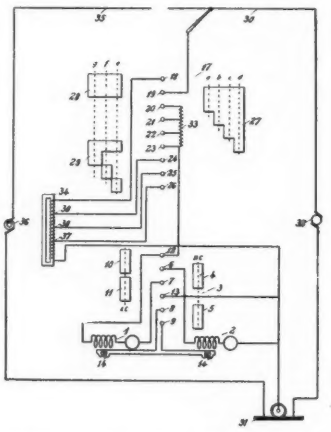
900,420. VARIABLE-SPEED MOTOR. Alvin A. Pifer and Charles E. F. Ahlm, Cleveland, Ohio, assignors, by mesne assignments, to F. B. Wagner, Cleveland, Ohio. Filed February 14, 1906. The regulator is equipped with two pole-shoe sections adapted to be moved from and toward each other.

900,426. SHADE AND SOCKET FOR INCANDESCENT LAMPS. Benjamin P. Rucker, Wilkinsburg, Pa. Filed June 21, 1906. The lamp socket is located entirely within, and sheathed by, the cap or dome of the shade.

900,429. ELECTROSONATOR. Ryusai Sakamoto, Tokyo, Japan. Filed April 11, 1907. A regulating socket is moved laterally to vary its point of contact on a spring plate.

900,447. ANTISEPTIC ATTACHMENT FOR TELEPHONES. Frank C. Tabler, St. Louis. Mo., assignor of fifty-one one-hundredths to Gus V. R. Mechin, St. Louis, Mo. Filed January 24, 1908. Fibrous material is arranged in front of, and parallel to, the diaphragm of the telephone. Means are provided for supplying said material with an antiseptic medium.

900,456. BLOCK-SIGNAL SYSTEM FOR RAILWAYS. James T. West, Rockingham, N. C. Filed March 25, 1908. A signaling circuit is adapted to be carried by a train or vehicle having a suitable signaling device therein responsive to current impulses through the track circuit.



900,289.—System of Control for Electric Motors.

900,458. TELEPHONE TESTING SYSTEM FOR PARTY LINES. Charles S. Winston, Chicago, Ill., assignor to Kellogg Switchboard and Supply Company, Chicago, Ill. Filed May 31, 1905. Means are provided whereby a special tone is produced in the operator's receiver when the busy circuit is closed.

900,476. COVER FOR ELECTRIC BATTERIES. Horatio J. Brewer, New York, N. Y. Filed May 29, 1908. The cover is arranged to carry the carbon and zinc elements and effect a moisture-tight cell.

900,478. ALTERNATING-CURRENT MOTOR. James H. Bryson, St. Louis, Mo., assignor to Wagner Electric Manufacturing Company, St. Louis, Mo. Filed October 7, 1907. Means are provided for shifting the pole phases.

900,486. ELECTRIC FURNACE. Erik Cornelius, Trolhättan, Sweden. Filed July 9, 1908. One electrode is fixed and the other is adapted to travel along the top of the chamber.

900,489. TELEPHONE EXCHANGE SYSTEM. William W. Dean, Elyria, Ohio, assignor to the Dean Electric Company, Elyria, Ohio. Filed October 18, 1906. An automatic ringing device comprising a ringing relay with line and generator connections.

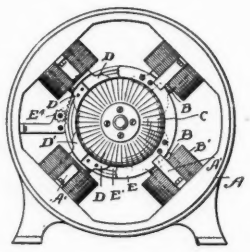
900,493. APPLIANCE FOR THE CURE OF RHEUMATISM AND OTHER DISEASES. Daniel R. Dewey, Hamilton, Ontario, Canada. Filed December 26, 1907. A blue-glass receptacle encloses an electric light filament, and is covered with a perforated non-combustible substance.

900,502. ELECTRODE FOR ELECTROLYTIC PURPOSES. Paul Ferchland, Berlin, and Joseph Nussbaum, Charlottenburg, Germany. Filed November 5, 1906. The conductors are dipped into a solution of lead sale, and current passed through said conductors and solution until a deposit of considerable thickness is formed.

900,529. PROGRAMME ATTACHMENT FOR CLOCKS. Julius W. Hansen, Princeton, Ind. Filed February 28, 1908. Means are provided to close an electrical circuit at any desired time.

900,542. ELECTRIC GENERATOR. Gottlob Honold, Stuttgart, Germany. Original application filed April 30, 1902. A high-tension spark generator.

900,553. TELEGRAPHIC RELAY. Isidor Kitsee, Philadelphia, Pa. Filed February 14, 1908. Means are provided to lower the resistance of a series of independent selenium cells through incoming impulses, and to move after each impulse the selenium cell formerly in the local circuit out of said circuit, and to move a selenium cell formerly out of said circuit in operative connection with said circuit.



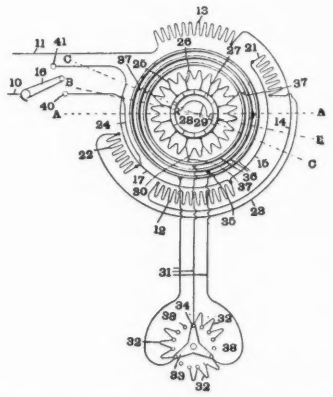
900,420.—Variable-Speed Motor.

900,555. CONTROLLING SYSTEM FOR ELECTRIC MOTORS. Benjamin G. Lamme, Pittsburg, Pa., assignor to Westinghouse Electric and Manufacturing Company. Original application filed December 4, 1905. Means are provided for arranging the circuit relations of the motors in accordance with the character of the energy supplied thereto.

900,571. SECONDARY BATTERY. William Morrison, Chicago, Ill. Filed June 8, 1903. A reversible electric galvanic battery.

900,597. PROCESS FOR PRODUCING AN ELECTROLYTIC DEPOSIT OF METALLIC CHROMIUM. Franz Salzer, Dresden, Germany. Filed January 16, 1908. Metallic chromium is produced by employing a bath containing a mixture of chromic acid and chrome oxide.

900,602. MASSAGE VIBRATOR. William G. Shelton, Chicago, Ill. Filed September 3, 1907. A motor operates the vibrating head.



900,478.—Alternating-Current Motor.

900,613. AUTOMATIC CIRCUIT-CLOSER FOR ELECTRIC-LAMP HOLDERS. William D. Tickner and Lucius C. Tickner, Blanchardville, Wis., assignors of one-half to Charles M. Crowell, Blanchardville, Wis. Filed February 3, 1908. The movement of the plunger closes the circuit and shifts the position of the lamp.

900,641. ELECTRIC FIRE ALARM. Harry Anderson, Haddonfield, N. J. Filed February 14, 1908. Fusible means are provided between a movable lug and a stationary lug.

900,658. REMOTE-CONTROL ELECTRIC SWITCH. Jay S. Bristol, Gillespie, Ill. Filed April 6, 1907. Means are provided for determining the direction of circuit closers.

900,676. TELEPHONE EXCHANGE SYSTEM. Ray H. Manson, Elyria, Ohio, assignor to the Dean Electric Company, Elyria, Ohio. Original application filed February 1, 1907. A plurality of ringing generators is adapted to supply current of different frequencies.